AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

MAY 1948

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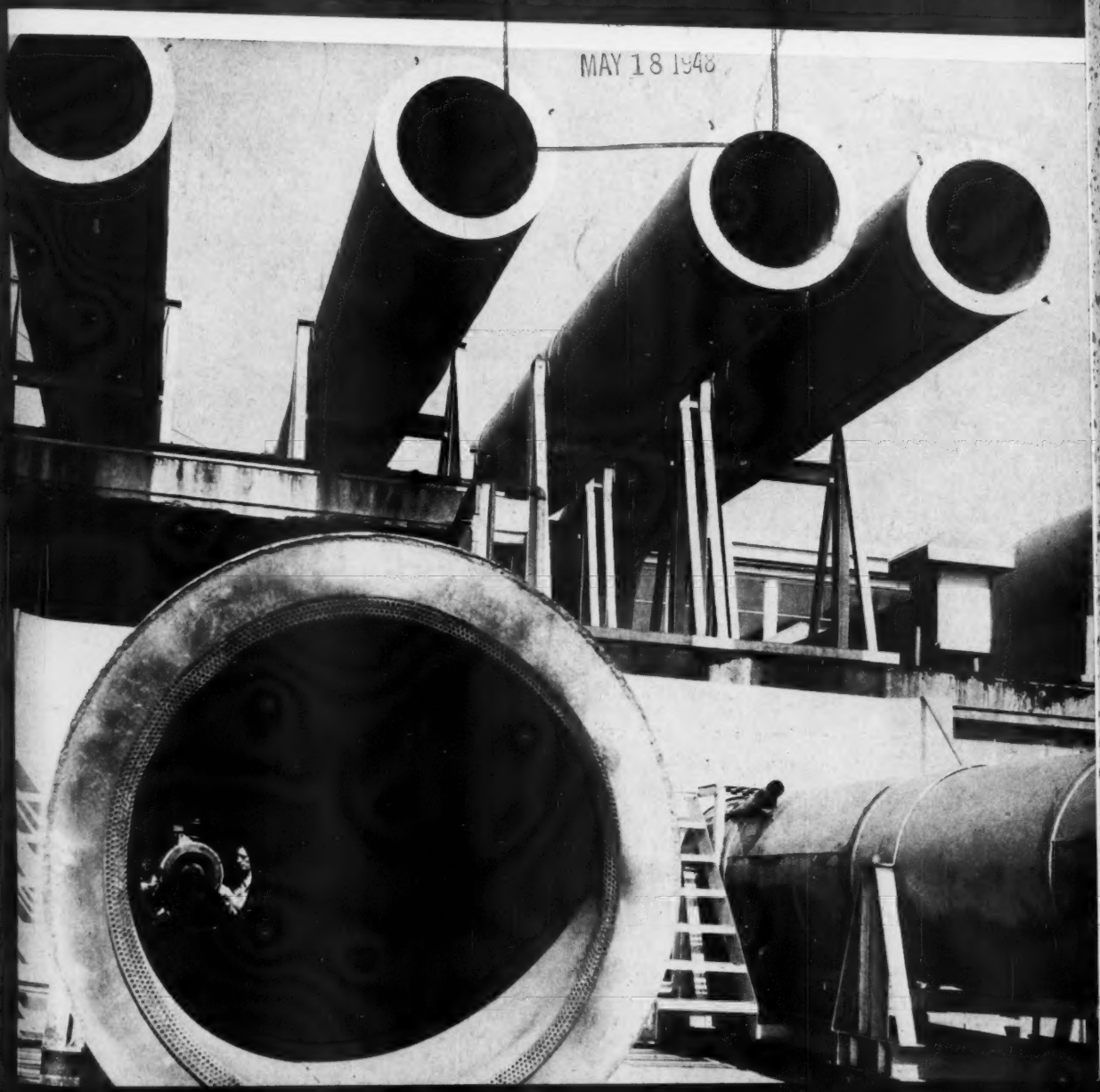

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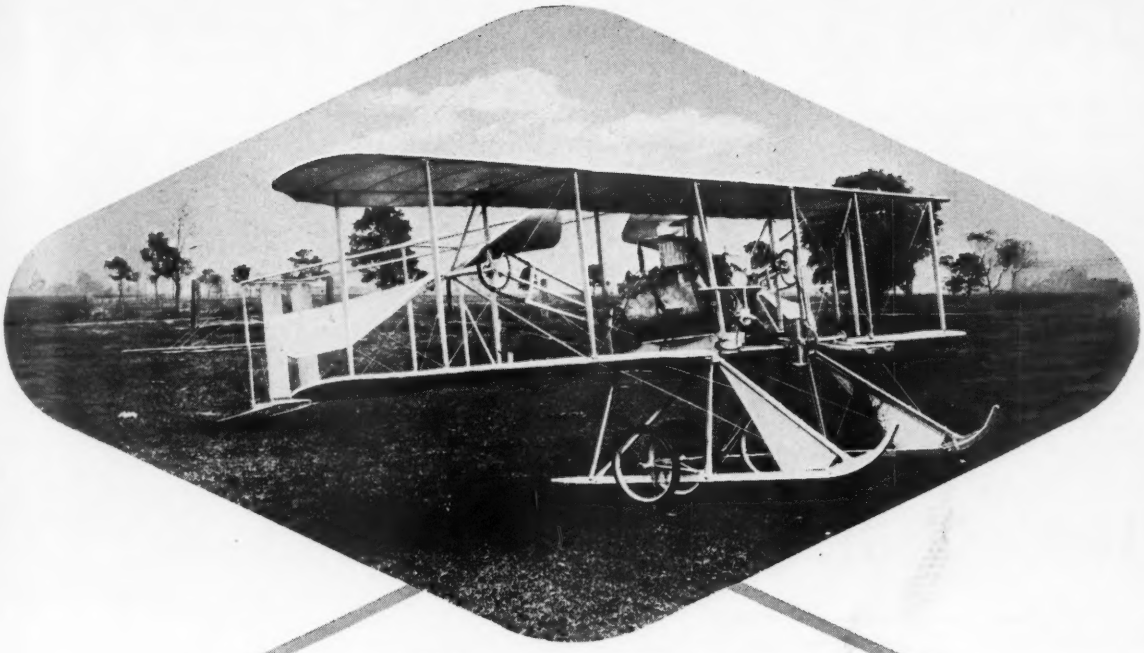

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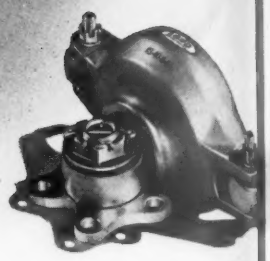


Lockheed *Uses* LORD Dynafocals

RS-40G ASSEMBLY

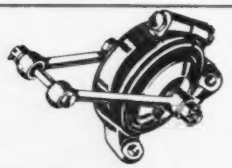
[Consists of six RS-40G-SA sub-assemblies]

For LOCKHEED "CONSTELLATION"
DOUGLAS AD-1 & AD-2
MARTIN "MARS" (JRM-1)
Using Wright R-3350-C18BB and C18BD engines

RL-35 ASSEMBLY

[Consists of nine RL-35-SA sub-assemblies]

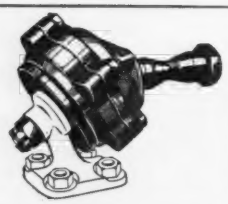
For LOCKHEED "CONSTELLATION" Using Wright R-3350 A & B Series Engines



MR-26 ASSEMBLY

[Consists of eight MR-26-SA sub-assemblies]

For DOUGLAS DC-4 (C-54)
Using Pratt & Whitney R-2000 Series Engines



MR-36, MR-36F, and MR-36J ASSEMBLIES

[Consists of six MR-36-SA; six MR-36F-SA; two MR-36J-SA and four MR-36J-SA1 sub-assemblies respectively]

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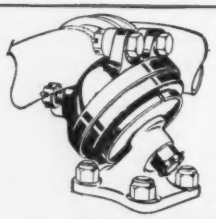
CURTISS CW-20 (C-46)
DOUGLAS DC-6 (C-112)
FAIRCHILD "PACKET" (C-82)
MARTIN 202
MARTIN 303



Using Pratt & Whitney R-2800 A&B Series Engines, use MR-36 Pratt & Whitney R-2800C Series Engines, use MR-36F, MR-36J

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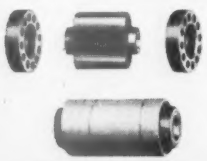

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Item	P & W 1830 Series Quantity Per Plane	P & W 1830 Series Part Number	Wright 1820 Series Quantity Per Plane	Wright 1820 Series Part Number
Tube Mounting	8	J1202-1	8	H5013-
Insert	16	J1789-1	18	SK1925
Sandwich	32	SK1292-1	36	SK1292

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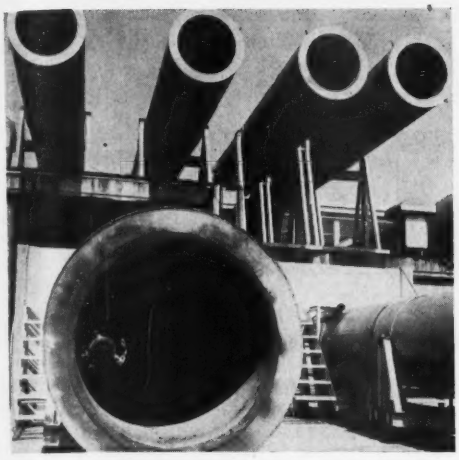

Cover—Modern jet engine test cell at Philadelphia plant of Westinghouse.

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AERONAUTICAL ENGINEERING REVIEW

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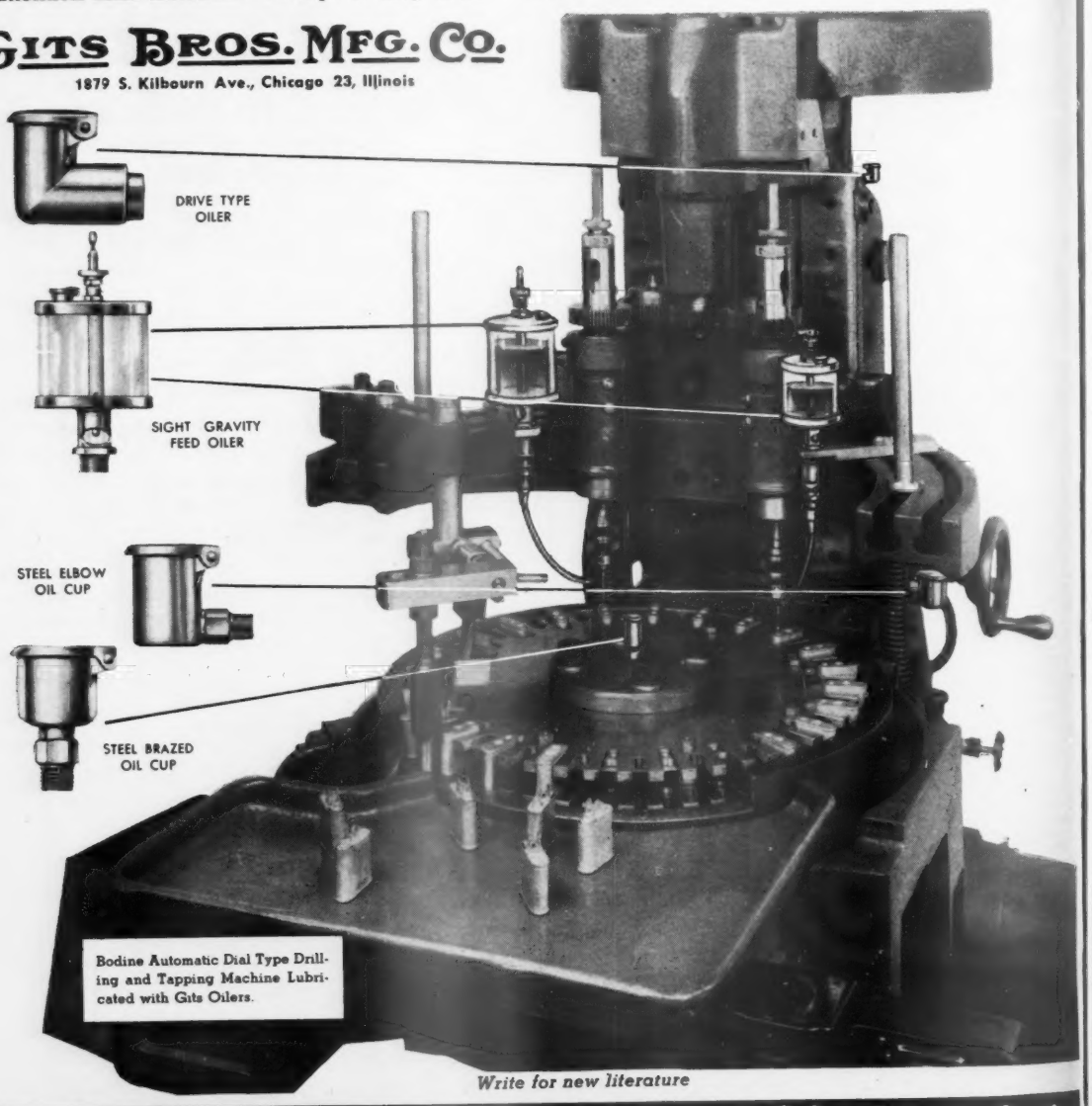

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I.A.S. News

A Record of People and Events of Interest to Institute Members

Fifth Personal Aircraft Meeting To Be Air-Borne

Three Meetings Scheduled in I.A.S. Move To Bring Institute to Industry; Itinerant Panel Discussers To Be Flown to Detroit, Wichita, and Dayton for Forum-Type, Free-for-All Audience Participation Meetings.

THIS YEAR the Fifth Annual Personal Aircraft Meeting is to be streamlined and adapted, not to speak of trisected, to fit the present economic realities facing light-plane manufacturers who, now more than ever, need strong technical support but feel they cannot afford to send their engineers and experts to distant technical meetings this year.

In planning this year's meeting, the Institute decided that, rather than cancel the meetings, as had been suggested, the Institute would bring the meetings to the industry.

▸ **Air-Borne Discussion Panel**—An itinerant panel composed of Arthur H. Tully, Jr., Research Fellow, Harvard University Graduate School of Business Administration and coauthor with Dr. Lynn L. Bollinger of the book, *Personal Aircraft Business at Airports*, to be published this month by the Harvard Business School; Jerome Lederer, Chief Engineer, Aero Insurance Underwriters; and an aeronautical engineering representative and a personal aircraft pilot to be named later. A complete program, including a full list of the itinerant panel members and events to take place, will be mailed to the I.A.S. membership before the meeting.

Grover Loening, Chairman, Roosevelt Field, Inc., and a Fellow of the Institute, will act as Chairman of the three meetings scheduled at Detroit, Wichita, and Dayton for June 7, 9, and 10, respectively, to which the panel will be flown.

Mr. Loening, well-known aeronautical engineering consultant, recently received the President's Medal for Merit for his services in aviation in World War II.

Air lift for the panel is to be provided by a Lockheed Lodestar, supplied through the generosity of Standard Oil Company of New Jersey, one of our Corporate Members.

▸ **Section Participation**—At each meeting, the local I.A.S. Section will organize, through committees selected and headed by the Chairman (Dr. Wilbur C. Nelson, of Detroit; Tom Salter, of Wichita; and Lt. Col. Albert A. Arnhym, of Dayton), the dinner meeting and technical session. Also, each Section participating will be represented on the discussion panel, with the permanent members, in its respective city.

Mr. Tully, the principal speaker at the three meetings, will present his talk on "What's Wrong with the Personal Airplane?" and will be followed by other panel members who will analyze his proposals from the engineering standpoint. Mr. Lederer will discuss the safety angle of personal planes. The meeting then will be thrown open to the audience for general discussion and argument.

▸ **Pilot, Economist**—Mr. Tully, in addition to his experience in investment banking, company and security analysis, is a pilot (served in the Civil Air Patrol from 1942–1944), a Past-Vice-President and Chairman of the Legislative Committee of State Aviation Officials, and Past-President of the Aeronautic Association of Boston. From 1944–1946 he was Director of Aeronautics, Commonwealth of Massachusetts. He served as Special Consultant on Personal Aircraft for President Truman's Air Policy Commission.

Following his graduation from Harvard in 1924, Mr. Tully entered the investment banking field in the firm of Lehman Brothers of New York and, subsequently, with the Massachusetts Investors Trust of Boston.

Personal Plane Meeting Chairman: *Grover Loening, well-known aeronautical engineer, will chairman the sessions of the Personal Aircraft Meeting in Detroit, Wichita, and Dayton next month.*

I.A.S. Calendar

June 7, 9, 10	Fifth Personal Aircraft Meeting—Detroit, Wichita, Dayton, respectively
July 14–16	Annual Summer Meeting, Los Angeles

For details see page 89.

I.A.S. Preprint Department Announces Expanded Services

Results of Initial Experiments Prove Practicality of Preprinting All Meeting Papers. New Coupon System Inaugurated.

PREPRINTS, the bane of practically every professional society's existence, have been a major problem and concern of the Institute ever since its inception. While the desirability of having copies of all meeting papers available at the time of presentation has long been recognized, a practical means of accomplishing this objective has been most elusive.

The printing and publishing of complex technical papers, replete with graphs, drawings, and pictures, is expensive business at best. To make preprints of such papers available in limited quantities at a reasonable cost is even more of a problem. Usually, to accomplish this undertaking successfully, one or more of the following are needed: (1) an unlimited budget or subsidy; (2) a high charge for the individual preprints; (3) mass-quantity production to reduce the unit cost (which presupposes a large demand and market); (4) a willingness on the author's part to supply his own preprints for distribution. In the past, the Institute has more or less relied upon the last.

A year ago, an experimental program was inaugurated to explore the various methods of reproducing papers and to find, if possible, a practical method of supplying preprints in limited quantities at a reasonable cost to Institute members. Sherman M. Fairchild sanctioned the use of the Publication Fund he had established during the war for this purpose.

It is too early in the game to aver that we have found all of the answers or completely licked the numerous minor problems involved. But the results of these experiments have been both gratifying and enlightening.

Annual Meeting Papers

The Sixteenth Annual Meeting offered the first proving ground for testing the results of earlier findings. With 30 papers scheduled for presentation under I.A.S. auspices, we stuck our necks out and promised to deliver preprints of every one of them. The net results: preprints of 21 papers were available at some time during the 4-day meeting; several more became available shortly afterward; and at the time of this writing, only one paper remains on the "missing" list. (The last is being held up pending final clearance and is expected shortly.)

More important, this test proved that the venture was economically sound and possible to maintain as a continued service. Over 2,000 preprints were distributed during the meeting, with mail orders accounting for an additional 4,000 up to March 1. While it is true that seven authors supplied us with several hundred copies of their own papers for preprint purposes, this was more than offset by the unusual length of the other papers produced through Institute resources. Some of these ran over 64 pages, thereby more than doubling the anticipated reproduction cost.

A closer cooperation with authors, the standardizing of manuscript preparation, and the establishment of certain limitiations will, in the future, increase the efficiency and effectiveness of this operation. It is planned to continue the policy of supplying preprints to I.A.S. members at one standard price of 30 cents; to nonmembers at 75 cents. It is further expected that preprints will eventually be available in advance of all meetings as the operation of this new service smooths out.

Fairchild Fund Papers

Numerous papers, never presented at meetings, are submitted to the Institute for publication. Many of these find their way into the JOURNAL or the REVIEW. Occasionally, the Editorial Committee is confronted with a paper that is too lengthy, or too specialized in nature, for publication in either magazine. Yet, the information contained in it may be of considerable value to a comparatively small but highly specialized segment of the Institute's membership.

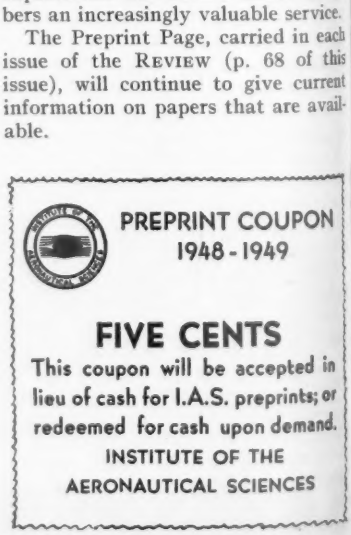
Under the present plan of operation, such papers are made available as Fairchild Fund Papers. They are reproduced by the Ozalid method and are individually printed as orders are received. Prices on Fund Papers vary depending upon the length and complexity of the manuscript and illustrations.

New Coupon System

A "coupon system" of exchange has recently been established to reduce the operational cost and to provide an added convenience to members. Coupons, in denominations of 5 and 25 cents, are available in sheet or book form and may be purchased at any time in any amounts ranging from $5.00 to $50. These coupons are accepted in lieu of cash for all I.A.S. preprints and are, of course, redeemable in cash upon demand. For members who expect to order preprints periodically, and especially for companies or libraries who order papers frequently, these coupons are particularly convenient since they eliminate the necessity of handling numerous small cash transactions.

The Institute has set up a separate Preprint Department, under its Director of Publications, to provide the specialized treatment these activities require. Under the capable management of Miss Ruth Meyers, it is anticipated that the department will render I.A.S. members an increasingly valuable service.

The Preprint Page, carried in each issue of the REVIEW (p. 68 of this issue), will continue to give current information on papers that are available.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Special Rate to Members for *Applied Mechanics Reviews*

Institute members interested in subscribing to the new *Applied Mechanics Reviews*, first issue of which came off the press in January, can take advantage of the special rate ($9.00) offered all I.A.S. members. Regular subscription rate for twelve issues per annum is $12.50.

Each issue of *A.M.R.* contains approximately 200 reviews culled from the output of some 500 magazines here and abroad, reporting and analyzing only those of the greatest significance. The reviews are written and signed by authorities and deal with important theoretical and experimental papers on solid mechanics, fluid mechanics, thermodynamics, and heat transfer, as well as applications of these to geophysics and to such specialized subjects as acoustics, ballistics, and lubrication.

Aeronautical Chapter Closed

In a letter received by the President of the Institute, Sir Geoffrey de Havilland and C. C. Walker of the de Havilland Aircraft Company Ltd., Hatfield, England, wrote:

"The death of Orville Wright closes a long chapter of aeronautical progress, the whole course of which can be surveyed only by the older people in aeronautics.

"It is difficult to recapture the atmosphere of 45 years ago, but the present writers recall very vividly the intense interest aroused by the rumored experiments at Kitty Hawk. Little or nothing was known about these events until the brothers came to Europe and demonstrated, and any rumors were received generally with incredulity. Fairly circumstantial accounts however used to appear in *The Scientific American*. These would have been unseen by most people here had it not been for a humble paper called *The English Mechanic*, which always reprinted them. It was through this medium that we, knowing flight was soon to arrive and having witnessed Maxim's trials, eagerly sought every paragraph referring to the Wright brothers' experiments.

"It was no sudden lifting of the veil for us when they came to Europe. We felt we had been in touch for several years with the progress of pioneer work which was about to reach triumphant realization.

"Those who were young men near the beginning of this century can see in perspective the great value of the Wright brothers' early work in the rapid development of aeronautics as it is today."

Last Chance for Roster Listing

With the MEMBERSHIP ROSTER scheduled for publication in September, 1948, a last call is being issued by the Membership Department of the Institute for latest data concerning present employment and titles, company addresses, and preferred mailing addresses of the more than 6,700 members.

▶ **Changed Job Since '44?**—The employment turnover in the aircraft industry among specialists and other professionals in the various fields has been exceptional since the war's end. Yet, the Membership Department often learns about a member's change in title, company, and address from secondary sources and only at a late date. Some members have not advised the Institute of changes in their status since 1944.

Requests have been flowing into the Institute from members wanting their copy of the revised issue of the ROSTER. It has been impossible to comply with these requests or compile the essential data in final copy for our printer because of the slow response of some members in forwarding information to us.

▶ **Deadline May 31**—All members who have had a change in status and/or address since filing the original roster card should bring our records up to date by submitting current data. For convenience, a card form is provided on page 67 of this issue. Deadline for receiving new and corrected listings has been set for May 31, 1948, after which date no further returns can be accepted.

I.A.S. Newslines

▶ On Continental Motors Corporation staff for 5 years as Consultant and Chairman of its Engineering Council, **Peter Altman** has been appointed Vice-President in charge of company's newly organized Multi-Tool Division. Mr. Altman, an Associate Fellow, will make his headquarters in new offices opened by Continental at 620 Ford Bldg., Detroit.

Appointed V-P: *Continental Motors Corporation announced it appointed Peter Altman, Consultant, Vice-President. He is in charge of newly organized Multi-Tool Division.*

▶ Among the engineers formerly associated with Willys-Overland Motors' Aircraft Research & Development Division who transferred with the Division when it became Research & Development Division, General Tire & Rubber Company of California, is **Leon Jerry Berman,** Associate Fellow and Research Engineer.

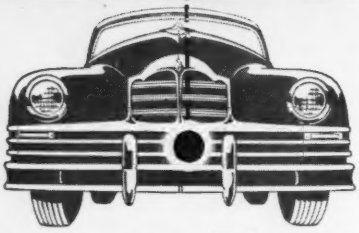
▶ "We must have a head to the present Joint Chiefs of Staff," urged Lt. General **James H. Doolittle,** Honorary Fellow, on the occasion of his acceptance of the General William E. Mitchell Award at the Wings Club in New York. Medal, founded by Frank Tichenor, publisher of *Aero Digest*, was awarded by Aviators Post 743 of the American Legion. General Doolittle said that, despite unification, our national defense establishment still consists of three "competing teams, the Army, the Navy, and the Air Force."

▶ **Sir Richard Fairey,** Honorary Fellow and Chairman and Managing Director of The Fairey Aviation Co. Ltd., has joined the board of The Fairey-Clyde Aviation Pty. Ltd., a new company formed recently. Fairey-Clyde Aviation is taking over plant and personnel of the Aircraft Division of Clyde Engineering Co. in Sydney, Australia.

Silicone News

DC SILICONES

Materials to Match Ideas



Packard adopts Houde Torsional Vibration Damper with DC 200 Silicone Fluid to absorb vibration of crankshaft.

Some of the best ideas die for want of the materials necessary to make them practical or for want of the time required to develop them. This might have been the fate of the ideas embodied in the Torsional Vibration Damper shown above. Use of a viscous fluid to smooth out the twisting motion of crankshafts was sound in theory—but impractical because there were no fluids which kept essentially the same consistency in use at high and low temperatures.

Engineers of the Houde Engineering Division of the Houdaille-Hershey Corporation were stymied until they requested samples of DC 200 Fluid in December 1944 and proved to themselves that this Silicone Fluid developed by Dow Corning had exactly the properties they needed. Even so, a great deal of time was required before the device could be perfected and its superiority proved on Diesel engines and finally on the 1948 Packard 8 and DeLuxe 8.

And the story of DC Silicone Fluids as damping media has just begun. We have learned from this and many similar experiences that equally useful applications of the basically different Dow Corning Silicone products may require an equal amount of developmental time. It's none too early to investigate their potential advantages. DC Silicone Resins, Varnishes, Fluids, Lubricants and Silastic* are described in Catalog S1-15, available from Midland or nearest branch office.

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▶ "Large, all-wing tailless airplanes may have better performance characteristics than conventional planes or tail-boom aircraft for certain types of missions," **Dr. Jerome C. Hunsaker,** Honorary Fellow and Chairman of N.A.C.A., wrote in his 1947 report to the White House. He declared also that "national security requires that expenditures for aeronautical research and development be expanded" and that this country "has contributed less than its due proportion to pure science."

▶ Civil Aeronautics Administration has appointed **Waldemar A. Klikoff,** Associate Fellow, to the post of Superintendent of Aircraft & Components Branch. He had been Chief, Airframe & Equipment—Engineering Division.

▶ New Executive Administrator, Pilotless Plane Division of Fairchild Engine & Airplane Corporation, **Guy A. Luburg,** I.A.S. Associate Fellow, had been Chief, Master Planning Department, at Edo Corporation.

▶ Formerly Theoretical Physics Consultant at the Naval Ordnance Test Station, **Dr. Milton S. Plesset** is now Associate Professor of Applied Mechanics, California Institute of Technology. He is an Associate Fellow of the Institute.

▶ Associate Fellow **Earl Pine Osborn** has been named Applied-Loads Engineer, Grumman Aircraft Engineering Corporation.

▶ Pan American World Airways' Vice-President in charge of the Pacific-Alaska Division, **Thomas Wolfe,** an Associate Fellow, resigned April 1 to go into business for himself. Veteran of 23 years in aviation and air transportation, Mr. Wolfe had joined P.A.A. in 1946, spearheading the company's biggest expansion program in the Pacific. A native of Nebraska, he authored technical book on air transport and management.

Gifts to the Institute Collections

General and Mrs. James H. Doolittle gave eleven bound volumes of *N.A.C.A. Reports.* Dr. Alexander Klemin added 197 periodicals, 65 reports, and 14 books to his previous gifts. Glenn D. Angle added books and pamphlets to his previous gifts. W. A. M. Burden added 175 periodicals of 1947 to his previous gifts. Mrs. Bella C. Landauer added two Argentine books, clippings, and magazines to her previous gifts.

More than 150 periodicals were received from Standard Oil of New Jersey through the courtesy of Miss Kathleen Garvey, and periodicals were added to its previous gifts by the Eclipse-Pioneer Division of Bendix Aviation Corporation through the courtesy of Miss Mildred M. Baker. The Cornell Aeronautical Laboratory added five translations to those previously sent, through the courtesy of Miss Elma T. Evans. Additions to his previous gifts of air-mail material were sent by Dr. Otto Kallir. The U.S. Forest Products Laboratory sent 65 reports. Periodicals were received from K. H. Weil, adding to his previous gifts. The David Taylor Model Basin sent eight reports and translations. A large collection of newspaper clippings on international aviation was received from J. C. Gardiner, Jr., through the courtesy of E. G. Scholze of American Overseas Airlines, Inc.

Among the donors of other gifts were the Aerophysics Institute, Inc., through the courtesy of Dr. August Raspet; Boeing Airplane Company; Dr. F. P. Bowden, of Cambridge, England; the Coordinating Research Council, Inc.; Curtiss-Wright Corporation; De Havilland Aircraft Pty. Ltd.; National Research Council of Canada; Port of Oakland, California; Radio Corporation of America; and the U.S. Civil Aeronautics Administration, Air Materiel Command, and National Advisory Committee for Aeronautics.

Corporate Member News

• Overhaul facilities are to be established in Australia by **AiResearch Manufacturing Co.,** Division of The Garrett Corporation, to service air-conditioning equipment in Constellations purchased by Qantas Empire Airways and Convair Liners ordered by Trans-Australia Airlines.

• An intensive air-freight sales and survey canvas of LA has been made by **American Airlines System.**

• Two 47D helicopters have been sold to the Directorate General of Agriculture, Iraq, by **Bell Aircraft Corporation** for crop dusting and to combat locusts. Bell helicopter production is at rate of three per week.

• Profitable fiscal year was reported by **Bendix Aviation Corporation,** which listed net income of $5,248,999 before special reserve adjustments for year ended September 30, 1947. Sales were $141,625,820 against $106,001,984 in fiscal 1946.

• Tests have been under way by **Boeing Airplane Company** with various sizes of ram-jet engines in a separate research facility at Renton, Wash., under U.S.A.F. program.

• Engineering work on a detachable-fuselage transport for U.S.A.F. is being undertaken by **Fairchild Engine & Airplane Corporation** in its new engineering offices in the Standard Oil Bldg., Washington, D.C. Based on the trailer-truck principle, the pack-plane, to be known as XC-120, will closely resemble the C-119.

• Heating pad for jet aircraft . . . . **The B. F. Goodrich Company** has developed a heated rubber pad for use on inner surface of cowl of a jet experimental aircraft. New anti-icing pad supplies heat at any desired spot without bulky and weighty ducting and control equipment, company says.

• Largest propeller in production by **Hamilton Standard Propellers Division,** United Aircraft Corporation, is 16½-ft. diameter four-bladed model being manufactured at the East Hartford plant. New prop is first reversing hydromatic type to use four hollow steel blades.

• Connies log 125,000,000 passenger-miles per month, **Lockheed Aircraft Corporation** reports, adding that Constellations have logged 2,000,000,000 passenger-miles since the ship first entered commercial service in February, 1946. Total of 123 are flying.

• With design work on a new helicopter project well advanced, **The Glenn L. Martin Company** has formulated definite plans to enter the 'copter field, possibly early next year.

• Total employment at **McDonnell Aircraft Corporation** will rise to 6,000, an increase of 2,600, by Spring, 1949; compares to wartime peak of 5,188. Employment in March stood at 3,465.

• **Republic Aviation Corporation,** which ceased production on the Seabee to concentrate on military orders, has sold Aircooled Motors, Inc., to Tucker Corporation, Chicago car manufacturer-to-be, which wants the Syracuse plant's facilities for engine production for its new automobile. Selling price was $1,800,000.

• Consolidated net sales of $10,413,687 and net profit of $514,817 for the 6 months ended January 31, 1948, are reported by **Solar Aircraft Company.**

• "Cube stick"—a yardstick combining a logarithmic scale, used for quickly determining cubic bulk of a package as a basis for assessing charges—has been tested by **United Air Lines, Inc.,** at its Chicago terminal. U.A.L. is putting the cube stick in use throughout its system.

• Menasco turbojet engine, XJ-37, has been taken over by **Wright Aeronautical Corporation** for development and testing. Originally started by Lockheed Aircraft, the XJ-37 project was transferred to Menasco under A.F. contract that extended to December 21, 1947. In mid-1947, however, because A.F. wanted project accelerated and Menasco would have had to make heavy capital expenditures for equipment to meet A.F.'s new requirements, the whole program was shifted to Wright Aeronautical.

LEADING MAN RICKENBACKER
Captain "Eddie" Rickenbacker, head man of Eastern Air Lines, Inc., has been in Hollywood portraying himself in the motion picture, "Air Power Is Peace Power." Shown here entering his portable dressing room, Captain Rickenbacker voiced a strong plea for building up U.S. air power.

Sections and Student Branches

Baltimore Section

David P. Lamson, Jr., *Secretary*

At the Section's February 27 meeting, the Constitution and By-Laws Committee reported on the proposed Constitution and By-Laws. At the same time, Preston Layton, Chairman of the Membership Committee, announced the beginning of a membership drive.

Captain C. H. Schildhauer, U.S.N., introduced speaker-of-the-evening Axel T. Mattson, Head, 8-Ft. Wind Tunnel Section, Langley Memorial Laboratories, Langley Field, who presented a "Résumé of Compressibility Airflow Problems."

Cleveland Section

S. D. Black, *Secretary*

The Section meeting of March 2 was attended by approximately 350, with Abe Silverstein, Chairman, presiding. Dr. Martin Summerfield, Rocket Propulsion Chief of California Institute of Technology's Jet Propulsion Laboratory, was the principal speaker. His subject was "Rocket Propulsion and the Problem of Escape from the Earth's Atmosphere."

Hagerstown Section

J. Anthony Pauli, *Secretary*

Opened by Chairman Roy Lessard, the January 30 meeting, attended by 27 members, featured three films and a short talk by Logan Waterman, Fairchild Aircraft Division of Fairchild Engine & Airplane Corporation.

Following a brief review of the I.A.S. Annual Meeting by Chairman Lessard, the meeting was turned over to Henry Billings, Chairman of the Program Committee, who introduced Mr. Waterman after the showing of *Mission of the Air Transport Command,* a film on the organization of the A.T.C.

▶ **Trim Tab Flutter**—Waterman opened his talk on the subject, "Trim Tab Flutter Characteristics," by explaining the fundamentals of vibration, considering a case of a single degree of freedom. Two examples of weight suspension by a spring attached to the ceiling were compared. In one instance, the ceiling was fixed, and in the other, it was movable.

The two systems were found to be identical and the response curve was the same if the oscillating force applied to the mass suspended from the fixed ceiling was equal to the mass times the acceleration of the movable ceiling.

An actual elevator and trim tab flutter test also was considered, with and without tab horns connected.

Following a short discussion of Waterman's talk, another film, *Ditch and Live,* was shown. A third film, *Land in the Jungle and Live,* concluded the meeting.

New York Section

E. M. Lester, *Secretary*

With an attendance of 175, the New York Section held its March 2 meeting in the McGraw-Hill Building auditorium, Charles Froesch, Vice-Chairman, presiding. Mr. Froesch introduced the speaker of the evening, Fred C. Rowley, of Grumman Aircraft Engineering Corporation.

▶ **Mallard Design**—Rowley discussed the design and development of the Grumman Mallard, supplementing his paper with lantern slides and films showing its construction and handling characteristics. An able presentation of the hydrodynamic development of the Grumman amphibian types, including the Widgeon, Mallard, and Navy XJR2F-1, was made.

It was pointed out that the hydrodynamic design incorporated in the Mallard and XJR2F-1 was based on

Northwest's Martin 2-0-2's fly with Sperry Gyropilot.*

Northwest Airlines has joined the many leading airlines that bring to their passengers the additional comfort and safety provided by automatic flight. The swift, luxurious Martin 2-0-2's that fly Northwest's "Overland Route" from coast-to-coast are now equipped with the Sperry A-12 Gyropilot to help the pilot do his job better.

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The Sperry Gyropilot gives the human pilot complete automatically stabilized control of his aircraft at all times . . . enables him to keep his plane proceeding smoothly on course and on time regardless of weather . . . lessens his tension and fatigue.

more passenger comfort and greater schedule reliability

Thus, the Sperry Gyropilot's accurate control of the aircraft brings to passengers the comfort of smooth flight even in rough air . . . to the pilot relaxation and higher efficiency . . . to the airline operator greater schedule reliability.

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Meet Your Section Chairman

(With this issue of the REVIEW, the editors present a new feature designed to acquaint members with I.A.S. Section Chairmen of their own and other local organizations. These sketches of the professional background of Section Chairmen will be published each month in alphabetical order of the local organizations.)

Joel M. Jacobson

Baltimore Section

Chairman of the newly formed Baltimore Section, Mr. Jacobson is Director of the Technical Engineering Department of The Glenn L. Martin Company, where he has held various engineering responsibilities since 1937. A native of Leeds, England, where he was born in 1907, Mr. Jacobson was graduated from Armour Institute of Technology (now Illinois Institute of Technology) in 1929 with a B.S. in Civil Engineering. He received his M.S. degree in 1933 and C.E. degree in 1934 from the same school.

▸ **Varied Engineering Experience**—Beginning his engineering career in 1929 when he joined Fairchild Airplane Manufacturing Corporation at the Farmingdale, Long Island, plant as Stress Engineer and, later, as Assistant Project Engineer, Mr. Jacobson the next year was named Assistant Professor of Civil and Aeronautical Engineering at Armour Institute of Technology where he remained until 1933.

Subsequently, he was connected with the following:

- Chicago's Lincoln Park Commission as Junior Bridge Engineer.
- General Aviation Corporation, Dundalk, Md., as Stress Engineer and Aerodynamicist.
- Fairchild Airplane (Hagerstown plant) as Stress Engineer.
- The Glenn L. Martin Company (1936–1942) in various capacities: Research Engineer; Assistant Project Engineer on the XPBM-1 and PBM-1; Chief Test Engineer, and Assistant Chief Structural Engineer.
- Fairchild Aircraft Division, Fairchild Engine & Airplane Corporation, where he was associated in the design of the AT-21 trainer, C-82 cargo plane, and Navy XNQ-1 trainer, in his capacity of Assistant Chief Engineer. He also was responsible for design of a new-type track landing gear.
- In August, 1947, he rejoined Martin in his present capacity of Director of Technical Engineering.
- Also, in the period 1938–1942, he was Instructor in Aerodynamics and Airplane Design at Johns Hopkins University Evening School in Baltimore.

At present Mr. Jacobson is in charge of engineering for Fire Control and Turrets, Pilotless Aircraft, and Electronics, and is responsible for the direction of Weights, Vibrations, Static Test, Aerodynamics, and Laboratory sections. In addition, he supervises new design development.

While at Hagerstown, he assisted in the organization of the I.A.S. Hagerstown Section.

During his career, he has published various technical articles in *Aero Digest* and the *Armour Engineer*, in addition to his theses.

Richard Edler von Mises

Boston Section

Professor von Mises, before arriving in this country in 1939, had built up a notable record as mechanical engineer, pilot, aircraft designer, instructor, and author of aeronautical technical works.

At present Professor of Aerodynamics and Applied Mathematics at Harvard University Graduate School of Engineering, Professor von Mises was born in Lemburg, Austria-Hungary, in 1883.

▸ **Studied in Vienna**—From 1901 to 1905 he studied at the University and the Technical College of Vienna and was graduated a Mechanical Engineer in 1906 and Doctor of Technical Sciences in 1908.

He worked as an engineer in engine plants from 1905, during which time he also was assistant and, later, design engineer at Brünn Technical College in old Austria.

Other notable points of his career include:

- Lecturer for Mechanics and Theory of Engines, Brünn.
- Head of Technical Service of "Prinz Heinrich Air Races," publishing on that occasion the first theoretical formulas for aircraft performances in flying races.
- Obtained International Pilot Certificate No. 500 in Berlin in 1913.
- Won 2 hours' flying prize from the "Deutsche Nationalflugspende."
- Made full Lieutenant in Austro-Hungarian Air Force, World War I.
- Designed 600-hp. bomber, the "Mises," which was built under his direction in 1915–1916.
- Was Chief of the Department for Aircraft Supply in the Austro-Hungarian Air Force.

▸ **Papers Published**—In addition, the first public edition of his *Fluglehre* (*Theory of Flight*) was printed in Berlin in 1918. Papers on two-dimensional airfoil theory, in which were given the first general formulas for lift and moment of lift of any airfoil section, were published in 1917 and 1919.

In 1919 he was appointed to full professorship for Hydro- and Aerodynamics at the Technical College of Dresden, and from 1920 to 1933 he was Director of the Institute of Applied Mathematics at the University of Berlin. In 1933 he became Professor of Mathematics at the University of Istanbul, Turkey, and in 1934 received an honorary doctorate from the University of Brussels.

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an extensive research program to improve water-handling, take-off, and landing characteristics for both smooth and rough water conditions.

Philadelphia Section

John Rogers, *Secretary*

On February 26, the Section held its Rotary Wing Meeting at the Sheraton Hotel. Commander Paul J. Burr, Vice-Chairman, presided. Members, totaling 150, heard three speakers on the subject of rotor craft and production costs.

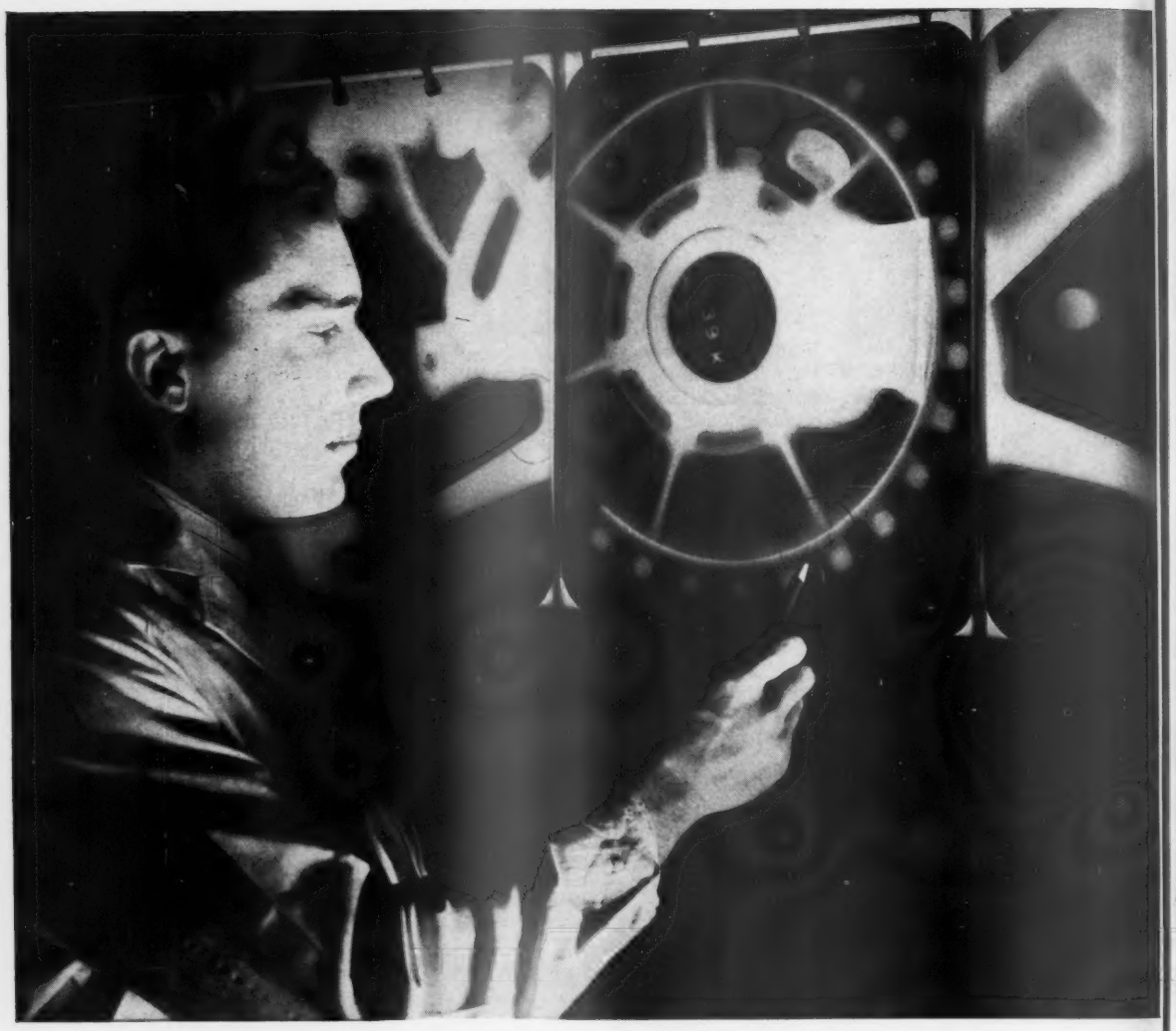
The meeting was preceded by a dinner in the Sheraton with 55 members present.

▸ **Stress and Vibration**—G. F. Doman of Doman-Frasier Helicopter, Inc., discussed stress and vibration characteristics of the articulated rotor and outlined the basic advantages of the nonarticulated, flexible rotor built for the Doman-Frasier 'copter.

The speaker offered his suggestion of the need for a standard rotor assembly package to be made available to the industry. Such a "package" would reduce helicopter costs considerably, he said.

Motion pictures of flight testing and detail construction of the helicopter were shown at the conclusion of his talk.

▸ **Brantly Design**—Knitting - machine manufacturer and mechanical engineer N. O. Brantly described the design and flight characteristics of his 'copter. Although not associated with



X-RAYS GET THE INSIDE STORY

▶ This Wright technician is reading an X-Ray negative of a vital engine part. The penetrating X-Ray has revealed a small flaw *inside* the casting — where the sharpest human eye would never see it.

▶ But like your family doctor, the Wright engineer is more interested in preventing trouble than in curing it. The findings of X-Ray are not limited to the rejection of parts. Information about the behavior and qualities of metals is passed along to the foundryman, the forgers, the countless others who make the parts.

▶ Better parts are the logical — and permanent — result. Technicians in the Wright Aeronautical laboratories X-Ray thousands of parts each month and 40 exposures are made on some of the more intricate pieces.

▶ Another example of the care — the instinct for perfection — used in development of Wright aircraft turbine and reciprocating engines.

POWER FOR AIR PROGRESS

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the aircraft industry or the field of aeronautics professionally, Mr. Brantly became interested in rotary wing principles and designed and built his own ship.

▸ **Helicopter Production**—Leslie E. Neville, Director of Standard Aeronautical Indexing System, and third speaker on the program, summed up the many changes made by the previous speakers in making their helicopters. He stressed the importance of standardization and simplification of helicopter design and construction if the industry is to enjoy mass marketing.

Seattle Section

Vaughn Blumenthal, *Secretary*

Meeting at the University of Washington's Guggenheim Hall on February 10, Section members, totaling 70, heard Al Hundar of California Research & Development Company on the subject of "Aviation Fuels—Present and Future."

▸ **High Octane Fuels**—Mr. Hundar gave a short historical summary of the development of high-octane aviation fuels beginning with World War I. He discussed in detail the various types of octane fuel currently being used in both reciprocating and jet engines, illustrating the applicable Army and Navy fuel specifications with slides. In addition, Hundar spoke of the extraordinary progress now being made in manufacturing improved fuels.

The meeting was concluded with the showing of the movie, *The Last Bomb*, dealing with B-29 development and action in the Pacific war theater.

Washington Section

M. B. Ames, *Secretary*

With an attendance of 110, the Section met February 12 in the Chamber of Commerce Building. Ivan H. Driggs, Chairman, presided. Two speakers were featured at the meeting: Capt. Walter S. Diehl, U.S.N., Bureau of Aeronautics; and Mr. Driggs.

Chairman Driggs reported that, as a result of business pressure, Edward Foley had submitted his resignation as Vice-Chairman. The resignation was accepted by the members with regrets, and Carl J. Wenzinger, of Navy's David Taylor Model Basin, was elected to serve Mr. Foley's unexpired term.

Among those attending the meeting were I.A.S. Director and Mrs. S. Paul Johnston.

▸ **Postwar German Aviation**—Captain Diehl in his talk, "What Has Happened to Aviation in Germany Since the War," discussed experiences on his recent technical missions to Germany. His talk was illustrated with about 40 slides showing German scientists and the ruins of their aeronautical research laboratories.

▸ **Prop-Jet and Jet Performance**—Chairman Driggs, who is Assistant for Design Research, BuAer, compared relative performance of propeller turbines and jet engines. A series of superimposed charts prepared by the Bureau's Aviation Design Research Branch illustrated his paper.

Academy of Aeronautics

The history and use of the slide rule was explained by Arthur Coletta, student speaker, at the February 3 meeting of the Student Branch. In addition, George Lord gave a short explanation of the compilation of design data being gathered by fifth term I.A.S. Student members. He stated that this extra information would be available to future members and that further information would be added.

Student papers occupied the entire February 10 meeting, which was attended by 53 members.

Joseph Ciavolella dealt with the use of leading-edge jets for airfoils. He explained how, in recent experiments, air is pumped under pressure through a tube that has its vent at a point on the upper surface of the airfoil, producing as much as 800 per cent increase in lift, he said.

Russell Lee then presented a paper on crash research in the aviation industry. A plan to lessen the serious effects of accidents was described. Briefly, it consists of installing thin sheet metal with a large area of "give" to absorb the major proportion of shock as the body comes to a sudden stop.

The next speaker, William Montgomery, discussed some of the important papers given at the I.A.S. Sixteenth Annual Meeting in January.

Final speaker, Norbert Kopchinski, explained the procedure undertaken by aircraft firms in wind-tunnel tests of new designs.

Aeronautical University

First meeting of the year on January 21 was opened by E. R. Baker, Vice-Chairman of the Student Branch, and election of the following officers took place: Chairman, Orland J. Engle; Vice-Chairman, Frank Biggam; Secretary, P. Drapala; and Treasurer, Harold E. Eastman.

At the February 17 meeting, with Vice-Chairman Biggam presiding, two films were shown: *High Altitude Flight and Aerobatics with the P-47* and *Report on Jet Propulsion.*

Two faculty advisers were chosen at the meeting the next day. G. W. Schwandt was elected Honorary Chairman and C. J. DaRos, Honorary Vice-Chairman.

On February 25, Lewis M. Churbuck, President of the University, gave a talk on "Opportunities Afforded Future Engineering Graduates in the Field of Aviation." Chairman Engle presided.

Alabama Polytechnic Institute

Following the showing of the film, *Gliding Wings*, an election of officers was held February 3, retiring Chairman W. H. Reed presiding. New officers for the Spring quarter are: Chairman, James L. Sanders; Vice-Chairman, Richard D. Cousins; Secretary, Vivian J. Cullivan, Jr.; Treasurer, Charles J. Renfrom. For Engineers Council Representative, Herbert C. Ryding was elected, and Owen B. Munro and John D. Roddam were elected Alternate Engineers Council Representatives.

Cal-Aero Technical Institute

Two films were shown at the February 17 meeting, Chairman Francis L. Wright presiding. The pictures, *Building of the B-19* and *Test Flight of Douglas Dauntless*, were substituted in place of the scheduled speaker, Jack B. Bauman, designer of the Brigadier 250, who was forced to cancel the engagement.

At the March 9 meeting, Art Chester, President, Professional Air-Race Pilots Association, summarized the development of air racing from World War I to the present, describing the newest type of "Midgets." Discussing the planes he designed himself, the Jeep, Goon, Swee-Pea, and the future Whimpy, Mr. Chester explained the advantages and disadvantages he had found in the V-tail. The disadvantages he hoped to overcome by use of a Y-tail in the design of the Whimpy.

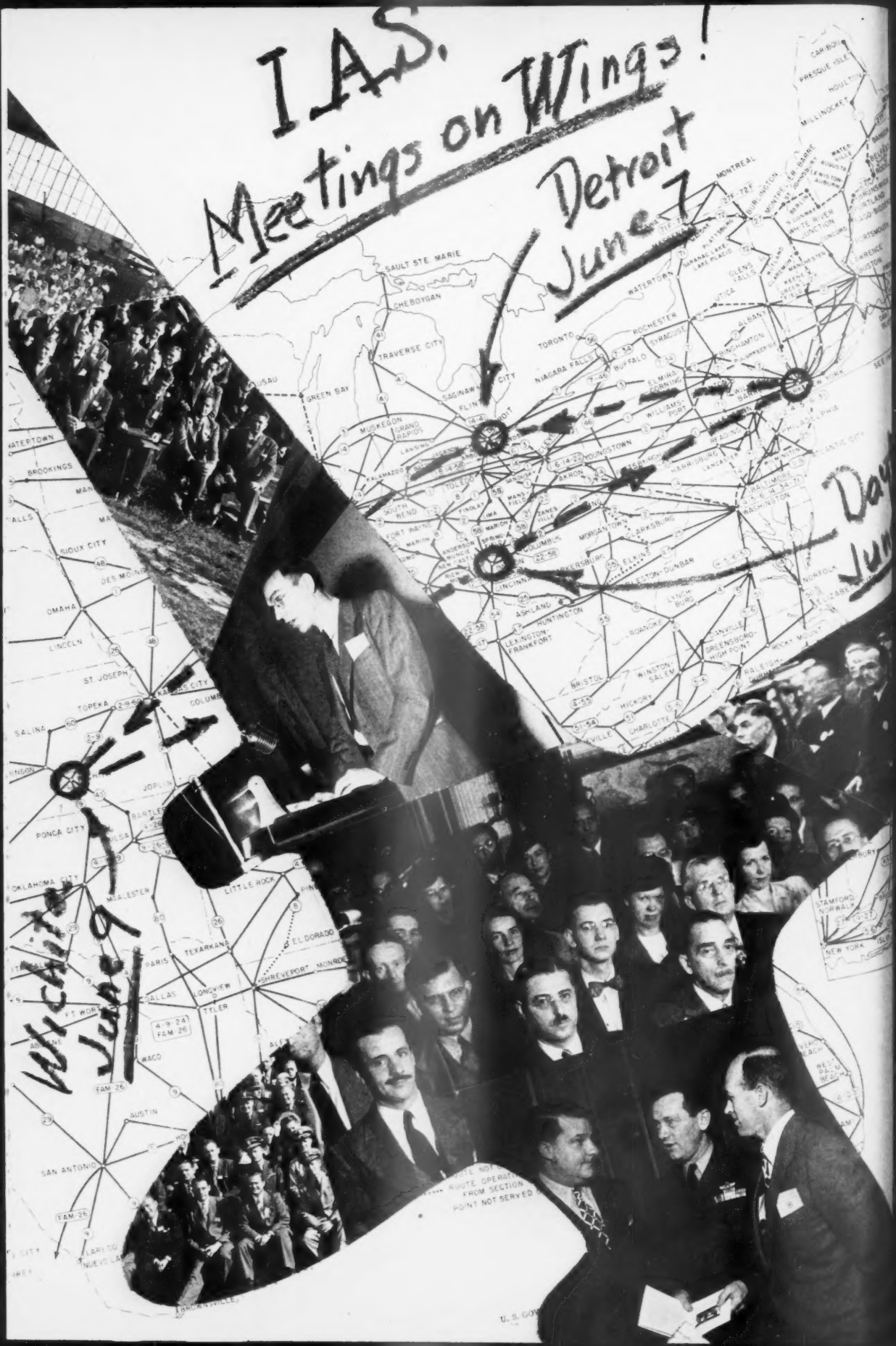
Motion pictures and slides of the 1946 and 1947 Air Races were shown.

University of Detroit

A special meeting to orient the Junior class with the nature and scope of the Aero Award Dinner was held March 4. The dinner is given annually, sponsored by the Junior Class of Aeronautical Engineers.

Distribution of *The Air Flow*, first edition of the Student Branch's official

(*Continued on page 79*)


I.A.S.
Meetings on Wings!
Detroit
June 7
Wichita
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Day
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SAULT STE MARIE
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TRAVERSE CITY
GREEN BAY
SAGINAW
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Editorial

Meetings on Wings

According to legend, a character named Mohammed once found himself embroiled in an impasse with a Mountain. When he was finally convinced that the Mountain would not (or could not) bestir itself to come alongside the Prophet, the Prophet very sensibly betook himself to the Mountain—a satisfactory solution for all concerned.

This year, in planning for our Fifth Annual Personal Aircraft Meeting, the Institute found itself in a somewhat similar dilemma. Manufacturers of the smaller nonmilitary planes are now in a critical period. They are fighting for their very existence. They are budgeting their available engineering man-hours and their travel expense dollars with the greatest of care. Many of them indicated to us that they could not afford to send their engineers and designers to technical meetings this year. A moratorium on National gatherings was suggested.

The management of the Institute, however, felt that such a plan was unwise. We had pioneered in the field of technical meetings designed specifically for engineers in light-plane categories. For the past four years, a series of outstanding National meetings in Detroit on personal-plane problems had established I.A.S. leadership in that field. Most important, it is *now*, if ever, that the light-plane industry needs strong technical support. Its main hope for survival may well be in the ability of its engineers to come up with something radically new, possibly some unconventional form of aircraft that will combine low cost with great utility. The Institute of the Aeronautical Sciences would be derelict indeed if it sidestepped its responsibility to provide whatever assistance it could to an important segment of its membership at this critical period.

So, we have taken a leaf from the Book of the Prophet. If the Industry cannot come to the Institute, this year the Institute will go to the Industry. We have developed the concept of the Mobile Meeting—an aeronautical Chautauqua—Meetings on Wings.

Elsewhere in this issue (page 5) details of the plan, something about the participants, and the general topics for discussion are outlined. An outstanding program has been worked up, and a competent troupe of performers has been recruited. The itinerary has been mapped out to include the main focal points of light-plane manufacturing activity. Air lift for the party is being provided through the generosity of one of our Corporate Members. With the cooperation of the respective local I.A.S. Sections, a series of dinner meetings has been arranged at which identical, carefully rehearsed programs will be presented. Meetings will be of the open forum type, with a provocative opening address, prepared discussion by the Itinerant Panel, and free-for-all audience participation, with no holds barred.

This plan is frankly experimental. As far as we have been able to determine, nothing of the sort has ever been attempted by any aeronautical society. We think it will work. We look upon it as one of the ways in which we can fulfill our obligation to provide the maximum possible service to our members. If it is successful it may well serve as a pattern for future I.A.S. activities—fast-moving meetings for a fast-moving industry—Meetings with WINGS! S. P. J.

A Review of the Third National Flight Propulsion Meeting—Part I*

By

S. DOREE BLACK

Associate Professor of Aeronautical Engineering
Case Institute of Technology

Dr. S. Doree Black.

At the Third National Flight Propulsion Meeting in Cleveland March 19, approximately 200 leading scientists and engineers specializing in jet and turboprop engines gathered to sound out the latest theories and practices relating to aircraft propulsion systems.

Most of the technical sessions were devoted to the design and research on new phases of flight propulsion, but the assembled scientists heard also from the largest operators of jet-powered aircraft in the world—the U.S. Air Force—on jet operation problems in the field.

The meeting was called to order by Abe Silverstein, Chairman of the Cleveland Section of the Institute of the Aeronautical Sciences, who introduced E. S. Thompson, Manager of the Aircraft Gas Turbine Division of the General Electric Company, the Chairman of the Morning Session.

The first speaker to be introduced was Dr. Pol Duwez who presented a paper produced jointly by himself and H. L. Wheeler, Jr., entitled "Experimental Study of Cooling by Injection of a Fluid Through a Porous Material." Dr. Duwez, Associate Professor of Mechanical Engineering and Chief of the Materials Section of the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif., was born in Mons, Belgium. In 1932, he received the degree of Metallurgical Engineer from the Mons School of Mines and in 1933 the degree of Doctor of Sciences in Physics from the University of Brussels. From 1933–1935 Dr. Duwez was a Research Fellow at the Daniel Guggenheim Graduate School of Aeronautics, California Institute of Technology, leaving there to become a Research Fellow and Professor at the School of Mines, Mons, Belgium. In 1941 he left Mons to conduct research at California Institute of Technology, becoming Chief of the Materials Section of the Jet Propulsion Laboratory in 1944 and Associate Professor of Mechanical Engineering in 1947.

H. L. Wheeler, Jr., was graduated from Stanford University in 1941 with a degree of B.A. in Physics. From 1941 to 1945 he taught ground school aeronautical sciences as instructor with the Army Air Forces. Since 1945 he has been a Research Engineer at the Jet Propulsion Laboratory, California Institute of Technology.

The material presented was obtained through joint sponsorship of the Army Ordnance Department, Washington, D.C., and the Air Materiel Command, Army Air Forces, Wright Field, Dayton, Ohio.

Dr. Duwez stated that, by making the parts to be cooled of a porous material and forcing the cooling fluid through the pores in a direction opposite to that of the heat flow, the coolant gradually increases in temperature, forming a protective layer on the surface exposed to heat transfer and enabling low surface temperatures to be maintained. This process is termed "sweat-cooling" and opens new lines of research in the fields of heat transfer, flow of fluids through porous materials, and powder metallurgy. The paper presented had the limited objective of defining the different variables involved in the problem and establishing the proper experimental techniques. A cylindrical duct of porous material (copper, nickel, stainless steel, and a porous ceramic were used) 1 in. in diameter and $1^1/_2$ in. long was inserted in a stainless-steel specimen holder separated from the holder by thermally insulating transite washers. Coolant is forced through the walls of the specimen from a small annular space between the holder and the specimen. (Nitrogen and hydrogen were investigated after a preliminary experiment using water showed that a critical value of the amount of coolant flow existed because of change of phase of the coolant when a liquid is used; but when a gas is used, the curve of surface temperature versus amount of gas coolant is continuous.)

The specimen is attached to a burner that supplies a high temperature, high velocity gas flow through the specimen. Two burners, one simulating conditions in the combustion chamber of a rocket and the other simulating conditions in a gas turbine, were used. Measurements were made of flame temperature, inside and outside wall temperature, rate of coolant flow,

* The Afternoon and Evening Sessions of this meeting will be covered in June issue of the Review.

Technical Sessions in the Hotel Carter's Rainbow Room.

central stream velocity, as well as other measurements indicating trends. In view of the preliminary character of the study, measuring devices and methods were kept simple and rugged, sacrificing precision for ease and versatility of measurement.

Measurements and analysis brought out the following interesting results:

(1) "The quantity of gas required for a given cooling effect is dependent upon the nature of the gas used as a coolant, the required rate of flow of nitrogen being about five times greater than that of hydrogen."

(2) "The surface temperature of the porous material is a decreasing function of the weight rate of coolant flow, when both temperature and velocity of the main gas streams are constant. The surface temperature decreases very slowly when the rate of coolant flow is increased beyond a certain value."

(3) "The relation of surface temperature to rate of coolant flow is influenced by both the temperature and the velocity of the main gas stream."

(4) "A correlation of all the results measured with any porous material and cooling gas may be obtained by using either one of the ratios $(T - T_1)/(T_1 - T_0)$ or $(T - T_1)/(T - T_0)$ and relating it to a function Q/W or to v/U where:

T = average temperature of the turbulent core
T_0 = temperature of gas entering coolant manifold
T_1 = temperature of sweat-cooled wall
Q = weight rate of flow of coolant per unit of area
W = weight rate of flow per unit area in main stream computed from V, T, and the density of the gas (considered to be air)
V = maximum velocity of main stream measured in center of turbulent core
v = velocity of coolant leaving porous wall
U = bulk or average velocity of main stream."

(5) "Only a fair agreement is obtained between the available theoretical studies and the experimental results. It seems, however, that most of the difference may be due to the fact that the experimental conditions do not correspond to those assumed in theories."

(6) "The experimental results indicate that, under the conditions present in this investigation, the nature of the porous material has a marked effect on the average heat transfer to the wall of the sweat-cooled specimen."

Dr. S. W. Yuan, of the Polytechnic Institute of Brooklyn, was called upon to present briefly the theoretical approach. He summarized a paper completed about a year ago ("A Theoretical Investigation of the Temperature Field in the Laminar Boundary Layer on a Porous Flat Plate with Fluid Injection," USN Project SQUID Technical Report No. 4, Sept. 5, 1947). This paper is to be presented at the Heat Transfer Symposium in June, 1948, at California Institute of Technology in conjunction with the University of California, Los Angeles, Applied Heat Transfer Symposium.

Herman H. Lowell, of the National Advisory Committee for Aeronautics, inquired of Dr. Duwez pertaining to methods of controlling the porosity of test specimens. Dr. Duwez remarked that a paper describing the methods of fabrication of specimens of controlled porosity had been presented in February before the American Institute of Metallurgical Engineers in New York. Preprints are available. The article probably will appear in the next edition of *Metals Technology* ("The Powder Metallurgy of Porous Metals and Alloys Having a Controlled Porosity," by H. E. Martens and Pol Duwez).

The Chairman, E. S. Thompson, introduced the next speaker, Frank E. Marble. Mr. Marble, a National Research Council Predoctorate Fellow at California Institute of Technology since 1946, is a native of Cleveland, having received his B.S. and M.S. from Case Institute of Technology. From June, 1942, until October, 1946, he worked at the Cleveland Laboratory of N.A.C.A., becoming Chief of the Fundamental Compressor and Turbine Research Branch. Mr. Marble's paper "The Flow of a Perfect Fluid Through an Axial Turbomachine with Prescribed Blade Loading" was prepared during the past year at California Institute of Technology.

The theory of the three-dimensional flow through an axial turbomachine, associated with variation of circulation along the blade length, was described as an extension of the classical theory of finite wings simplified to a problem in axially symmetric rotational fluid motion by considering an infinite number of blades in each row. This problem of flow through coaxial cylinders (inner hub and outer shroud) results in a nonlinear partial differential equation. The problem was linearized by considering the vorticity generated by the blades to be transported by the mean velocity and not by its own induced velocity. The resulting solutions provide the linear approximation to the radial, tangential, and axial velocities associated with any prescribed loading of a blade of finite chord or of an infinitely thin blade row corresponding to an actuator

disc or lifting line. The boundary conditions imposed in the solution of the linearized equation are that the radial velocity component be zero at the inner and outer cylinder surface and at a distance far upstream or downstream from the section or actuator, that the tangential velocity far downstream be equal to the initial tangential velocity far ahead of the first blade row, that the axial velocity far downstream be equal to that far upstream, and that the blade loading or velocity distribution be prescribed throughout the annular space at the actuator occupied by the fluid. Because the problem has been linearized, the solution for a multistage turbomachine may be obtained by superposition of appropriate single rows.

An analysis of a single blade row of a prescribed loading, with a hub-tip ratio of 0.6, blade aspect ratio of 2, for stationary and rotating blades, was presented showing graphically the velocity components and comparing these results with the corresponding lifting line approximation. This showed that when the line is located appropriately the results constitute a useful approximation to the solution for a finite blade chord.

A simple means of approximating the axial velocity distribution in a multistage turbomachine and of discussing mutual interference of blade rows was presented.

Dr. F. G. Gravalos, of Rennselaer Polytechnic Institute, mentioned a recent Doctorate thesis of a similar nature by R. E. Meyer while at the Federal Technical Institute of Switzerland (now at the University of Manchester, England). Mr. Marble commented that Dr. Meyer's paper is similar only in that a similar problem was attempted. Dr. Meyer, however, made other simplifying assumptions resulting in the establishment of different boundary conditions for the solution of his equations.

Dr. Hans Reissner, Professor of Aerodynamics, Polytechnic Institute of Brooklyn, briefly reviewed another approach that allows isentropic flow and does not require linearization for solution. However, the boundary shape is not fixed *a priori*. This paper, entitled "Blade Systems of Circular Arrangement in Steady, Compressible Flow," was prepared for the *Courant Anniversary Volume, 1948*, after having been given in a graduate course at the Polytechnic Institute of Brooklyn in the Spring Term of 1946. The paper is to be published at a later date. Dr. Reissner's approach to the problem of circular blade systems assumes at first an axially symmetric flow (infinite number of blades). The continuity equation is modified by introducing such a distribution of pressure and of one component of the velocity that requirements of compression ratio, velocity, and prevention of flow separation are satisfied. For an axial compressor the axial velocity and for a centrifugal compressor the radial velocity is prescribed. A simple quadrature then furnishes the distribution of the second velocity component. The third (circumferential for the axial flow compressor) component in terms of the radial and axial coordinates is then found by the Bernoulli energy equation derived from the Euler equations of compressible flow either for a rotating or a fixed coordinate system. This equation also indicates the limits of angular speed, compression ratio, length of blade and thickness of hub, beyond which the circumferential velocity becomes imaginary. After the entire velocity distribution is determined, the shape of the blades and of the inner and outer wall is readily determined by the equations of the streamlines ($dr/dz = u/w$, $rd\phi/dr = v/u$, $rd\phi/dz = v/w$). The power requirements, temperature rise, and forces on the blades may then be determined. The transition to finitely spaced blades is derived by replacing the uniform force system between the blades by the addition of those circumferential inertia forces that had to be left out in the flow of axial symmetry. In this way the originally continuous force distribution is transformed into a set of pressure discontinuities representing the blades.

E. S. Thompson introduced the third speaker, J. W. Bailey, Head, Service Engineering Section, Allison Division, General Motors Corporation. Mr. Bailey joined the Allison Division in 1939 after having been previously employed in the Power Plant Branch at Wright Field, Dayton, Ohio. For the past 4 years he has been Head of the Service Engineering Section, which is responsible for the correlation of installation problems with aircraft manufacturers, the publication of Service Technical Orders, and the liaison between the Service and Engineering Departments on field service and overhaul problems. Mr. Bailey presented "Service Experience with Turbojet Engines."

"The turbojet engine, unlike its aircraft power-plant predecessor, has not had the advantage of many years of development and service experience normally re-

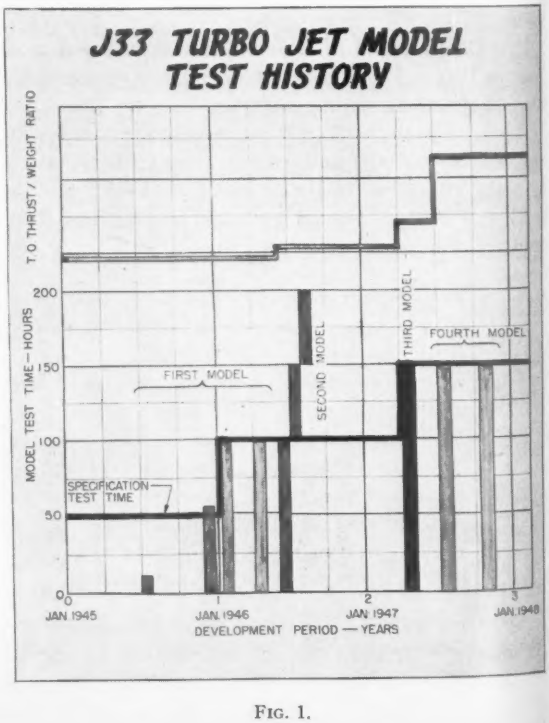

FIG. 1.

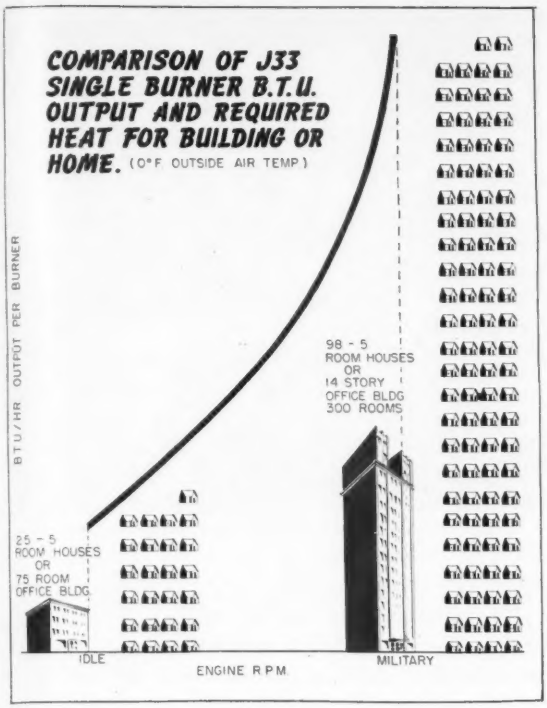
COMPARISON OF J33 SINGLE BURNER B.T.U. OUTPUT AND REQUIRED HEAT FOR BUILDING OR HOME. (0°F. OUTSIDE AIR TEMP.)
B.T.U./HR. OUTPUT PER BURNER
98 - 5 ROOM HOUSES OR 14 STORY OFFICE BLDG 300 ROOMS
25 - 5 ROOM HOUSES OR 75 ROOM OFFICE BLDG.
IDLE
ENGINE R.P.M.
MILITARY

FIG. 2.

quired to produce a dependable engine having practical service life between overhauls. The development of the turbojet engine in the United States dates back only slightly over 3 years. However, several thousand hours of endurance running have been accomplished at Allison since 1945. In addition to this time on experimental test stands under the direction of development and design engineers, service flight time rapidly approaching 100,000 hours have been accomplished primarily in the P80 airplane . . . . With the present limitations of experienced personnel and the reduction of development funds in a limited peacetime economy, it is necessary for the aircraft industry to take advantage of these past 3 years of experience for the United States to maintain its present position with regard to world air power. . . . Nearly 100,000 service flying hours with the J-33 turbojet engine, like any new power plant, has not been accomplished without some difficulty. Engine development, however, has been rapid, as can be seen from the diagram of model test history and take-off thrust ratings over the 3-year period." (See Fig. 1.)

Excess stresses in various components of the engine may be obtained by subjecting the engine to excess power requirements by supplying for short periods an excess amount of fuel through the engine fuel system. A short discussion of production engine performance, performance versus service time, installation problems, service experience, fire hazards and accident rate followed. Difficulties and experiences with fuel systems, burner blow-out, "hot starts" (that is, excessive fuel before adequate turbine speed has been reached resulting in sudden excessive temperature), turbine wheels, turbine blades, burner liner and other combustion chamber parts, ignition and electrical systems, compressor impeller stresses and vibrations were discussed. Interesting illustrations shown were those comparing the J-33 single-burner B.T.U. output and required heat for building or home (see Fig. 2).

Time did not permit discussion from the floor. The chairman introduced Neil Burgess, of the Aircraft Gas Turbine Engineering Division, General Electric Company, who discussed "An Evaluation of Engine Design Compromises." Mr. Burgess received his B.S. in Mechanical Engineering in 1939 from the University of Rochester and his B.S. and M.S. in Electrical Engineering at M.I.T. in 1941. Since 1941 he has been assigned to the Aircraft Gas Turbine Engineering Division, General Electric Company.

Mr. Burgess stated: "The apparent simplicity of the turbojet engine relative to the reciprocating engine has frequently been pointed out in technical literature. As tangible evidence that this has been true, the Army J-33 engine, which was approximately double the size of any turbojet engine then in existence, was designed and built in approximately 6 months.

"It must not be inferred from this record of past performance that such dramatic achievements will be possible in the development of future turbojet engines. Engines produced to date have been thermodynamically conservative and must be considered primitive in comparison with the ultimate potentialities of the thermodynamic cycle. In particular, the thermodynamic performance in terms of thrust per unit of size and weight and fuel economy under flight conditions is capable of substantial improvement. In addition, the life of current engines is below expected values based on the properties of materials in use today.

"In every phase of engine design, starting from the thermodynamic cycle analysis and continuing until large quantities of engines have been delivered, it is necessary to compromise the ideal engine if a design is to be obtained which will be useful and which can be developed soon enough to have tactical value. It has been only as a result of these compromises that the rapid evolution of the turbojet engine has been possible.

"The criteria for evaluation of any aircraft engine are: (1) thermodynamic performance, (2) operating life, (3) installation features, (4) availability, (5) cost.

"In present engine designs the most critical single component from the standpoint of performance is generally the compressor. For a given thrust output, numerous compressor arrangements are possible, each different with regard to performance, size, or weight . . . .

"The combustion systems on present turbojet engines have losses that affect performance: pressure drop, incomplete combustion, and imperfect exit temperature distribution. Losses are not substantial, however, and the most extensive development work is

(*Continued on page 21*)

Problems Incident to the Operation of Jet Aircraft

Excerpts from the Luncheon Address at Cleveland, March 19

By Major R. L. Johnson

U.S.A.F. Fighter Test Branch, Flight Test Division, A.M.C.

"ON YOUR PROGRAMS you have probably noted the topic chosen for me to discuss is "Problems Incident to the Operation of Jet Aircraft." The topic more appropriately might have been "Problems Incident to the Operation of Jet Fighter Aircraft." My experience with jet aircraft has been limited to fighter types. Time will not permit a detailed discussion of the problems involved. In all probabilities the ones to be mentioned will not be new to all of you. I don't doubt that some of you have spent and will spend years on one or more of the problems to be mentioned. It is hoped, however, that one or more might serve as a seed in the fertile minds of the recipients, which may grow and become the fruit of solution.

"In actual operation of aircraft, the first possibility for a problem is during the 'start' of the engine. In the jet engine temperature control has been found to be the most important issue during the start. With inexperienced pilots and ground crew 'hot starts' (starts where higher than maximum desirable temperatures are experienced) are nearer to being the rule than the exception. A 'hot start' is often an expensive accident. From a military standpoint it is expensive in consideration of material, labor, and temporary loss of an aircraft from missions for which it might be needed. Occasionally, an air start is necessary because of faulty throttle operation. Short life of spark plugs tend to make 'air starts' somewhat uncertain. A solution to the difficulties mentioned might be a one-control automatic starting device with a temperature sensing unit. The sensing unit would meter the fuel in such a way that excessive temperatures during starting would never be reached. A different type of ignition system or one that incorporated spark plugs with a known useful life would also be desirable.

"The cockpit or cabin of the jet aircraft could be compared to a difficult puzzle with a maze of parts that seem impossible to assemble with a proper and fitting relationship. Pilot comfort, mental and physical, is, of course, the ultimate solution. During emergency conditions that dictate jettisoning of the canopy or cockpit enclosure we find ourselves in a critical situation caused by turning of the canopy as it leaves. The forward corners of the canopy have been known to strike fatal blows despite protective headgear. Exit at high speed is also known to be dangerous. Striking the empenage is the main hazard. The problems mentioned concerning emergency exit are the prime reasons for mental discomfort. Physical discomfort as concerns the pilot comes from a multitude of reasons. The main problem associated with physical discomfort is the detrimental effect on pilot performance. An individual numbed with cold is, of course, less efficient than one who is comfortable. Being too warm is also often a reason for loss of, or lack of, efficiency. We are aware then that temperature control of the cockpit is an important consideration. Discomfort caused by restricted space, such as inadequate leg room, is another problem. Poorly positioned controls and switches are contributing factors to discomfort and to accidents.

"Take-off with jet aircraft is usually more critical and more of a problem than with propeller-driven aircraft. Ambient temperatures have a greater effect on jet engine performance than on reciprocating engines. Reduction in thrust is apparent with increase in temperature. Aircraft with near critical take-off performance on cool days have critical take-off performance on hot days. Conditions, such as obstacles at ends of runways, sometimes necessitate downwind take-offs. Conventional aircraft are affected only as concerns the air frame, while engine performance is also adversely affected with the jet-powered aircraft.

"Flight instruments of the gyro type have also become a problem with the advent of the high true speeds associated with jet-powered airplanes. Turn errors have become excessive and cause or constitute a hazard during instrument flying conditions. A lack of instruments and/or a method that will expedite blind landings from a time and ease of operation standpoint is a problem of paramount importance, since fuel consumption is high at low altitudes.

"Lack of sufficient air brakes to permit vertical descents at the maximum controllable velocity, level flight of the aircraft, constitutes a problem peculiar to dive bomber and fighter aircraft. Lack of the type

brake mentioned also creates two additional problems. Jet airplanes are very clean as a consequence; without adequate brakes their deceleration is slow. During the approach for landing with power-off, a wave-off or go-around is sometimes critical because of the slow acceleration of the jet engine. Brakes could be used to cover that deficiency.

"Power boosted controls constitute a problem when failure of the power source occurs during combat conditions because of enemy action and with differential lateral loading, such as experienced when external fuel tanks are drained separately. When mechanical failure occurs and the boost is lost, the force required of the pilot is instantaneously increased in direct proportion to the boost ratio. The force required to maintain controlled flight is usually greater than a pilot can apply. Trimming controls, position and speed of reaction are related problems. Because the trim tab power is often too low, the control inconveniently located and its reaction slow, we are left without an auxiliary control boost. The trim tabs could be utilized as a control boost if that thought were in mind during their design.

"Lateral and directional stability at high altitudes with boosted controls, which require a fairly high 'break from neutral force,' is also a source of irritation. Control forces, at lower indicated air speeds which occur at high altitudes, are usually light. When a relatively high force is required to initiate the control action, overcontrol usually results.

"Engine control, particularly during landing, is usually not sensitive enough. It is also a difficult problem to cope with during formation flying.

"High fuel consumption is a problem of paramount importance and one that is difficult to solve. Fuel consumption is highest at the altitudes at which the highest true speed is attained. Air miles per gallon is lower at altitudes where the true speed is the greatest, which means the maximum range of the airplane must be realized at altitudes where performance is restricted.

"The last problem to be mentioned in connection with the operation of jet aircraft is the airfield itself. Operation of jet aircraft is restricted to comparatively few airfields because of their limited size.

"There are a great number of minor or associated problems that we have not mentioned and in all probabilities several that we have not as yet encountered. It is believed that the problems mentioned are the major ones concerning jet airplanes of the present."

A Review of the Third National Flight Propulsion Meeting—Part I

(*Continued from page 19*)

generally for mechanical reasons rather than thermodynamic.

"The principal problem in the design of the combustion system is to obtain satisfactory life without excessive size and weight . . . .

"As a result of the experience gained from research and development work on steam turbines, the thermodynamics of turbine design have become well known and are straightforward. The engine turbine differs from the steam turbine only with regard to the mechanical problems associated with very high temperature operation and the requirement for low weight . . . .

"In order to improve take-off characteristics and to provide increased thrust for use under combat conditions, thrust augmentation is receiving considerable attention on engines now under development . . . .

"As the evolution of the turbine engine continues, it may be expected that it will incorporate a higher degree of thermodynamic refinement as one step toward the improvement of performance. This will be possible by reason of the fundamental research data being obtained on facilities now becoming available in private industry, as well as in the various excellent Government facilities. Since life and reliability will become more and more important and since the more highly refined engine will require more testing prior to production, it may be expected that more mechanical refinement will be incorporated while the engines are in production to the extent permitted by interchangeability in order to maintain the production engine at the highest practicable level of refinement."

No discussion of this paper ensued. The meeting adjourned at 12:15 for luncheon.

Unified Design for Performance and Safety Characteristics

By
FREDERICK W. ROSS*
University of Michigan

Editorial Note—While this paper deals with an airplane that was never put into quantity production, it contains several original contributions which the editorial committee felt would be of interest to many REVIEW readers.

(I) Introduction

The selection of the optimum combination of the design parameters that determine the flight and ground handling characteristics is one of the most important problems confronting the airplane designer. While considerable data are available for this selection, many factors are involved and their relations to the performance and safety are not well defined. As a result the designer usually treats the elements that define the problem essentially as separate problems rather than as a unit, and insufficient consideration is given to the effect of the separate elements on the resultant design.

The flight and ground handling characteristics can be divided into two categories—namely,

(1) Performance, relating to efficiency of the airplane.

(2) Safety characteristics, including all items of performance, flight, and ground handling which relate to safety.

This division of characteristics suggests the use of a two-dimensional chart for rating airplanes. With a factor representing performance as ordinate and another for safety as abcissa, both expressed in terms of the design parameters or their effect on the design, the chart provides a means for treating the entire design problem as a unit. By noting the position of an airplane on the chart as a function of the design parameters, those parameters that give the most desired position can be selected.

A performance rating factor is derived using the power required and power available curves. It is expressed in terms of quantities obtained from usual flight tests and provides a definite quantitative measure for the ordinate of the chart. It applies to aircraft of all sizes and types.

The safety rating factor is more complicated and comprises items whose relationship to the resulting safety must be defined from statistical data. As a consequence, the safety rating factor is given as the sum of a list of items each assigned a weighting factor in accordance with available statistics. A different safety rating factor will have to be used for each type of aircraft such as personal, transport, and fighter.

A safety rating factor is established for a personal type airplane, and the relation between each of the items and either the design parameter or its effect on safety is given.

Effective use of the chart has been made in the development of a wing-flap-aileron combination of unusual characteristics as shown by wind-tunnel data. Further application of the chart has been made in the design development of a two-place tractor airplane utilizing the wing-flap-aileron combination mentioned. The resultant flight and ground handling characteristics for the airplane as obtained from flight tests are cited as further evidence of the value of treating the entire design problem as a unit.

(II) Performance-Safety Rating Chart

Many design features that may be incorporated to improve such safety characteristics as stability, control-

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lability, and stall reduce the performance, and in general it is noted that maximum performance usually is not compatible with maximum safety.

The effect of this apparent incompatibility can be indicated by rating airplanes according to their relative performance and their relative safety characteristics. This is shown on the chart given in Fig. 1. The ordinate represents a performance rating factor, F_p, and the abcissa, a safety rating factor, F_s.

Airplanes designed without the aid of an analysis such as presented here fit on the chart somewhere in the shaded area. They tend to have either good performance and comparatively poor safety or good safety characteristics but not a very high performance rating. The ultimate goal of every designer, of course, is to have a model that fits on the chart as far to the upper right as possible.

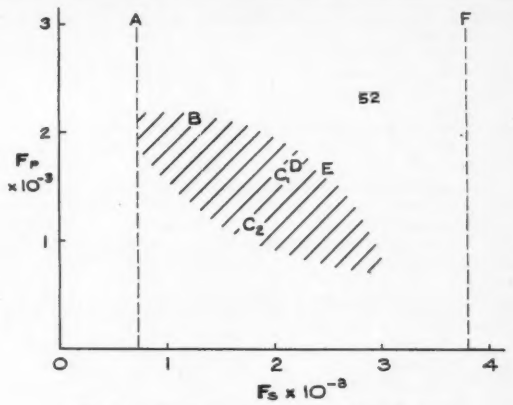

FIG. 1. Performance-safety rating chart.

Performance Rating Factor

The performance of an airplane is characterized by the area between the power-required and the power-available curves. This area is approximately proportional to the product of the maximum excess power times the speed range (the high speed minus the stalling speed). The area alone, however, does not give a complete picture. The three sets of curves shown in Fig. 2, which enclose equal areas, do not represent airplanes having equivalent performance. By dividing the area by the two ordinates, power and velocity, a factor is obtained which has a positive monotonic relation with the performance.

A performance rating factor may be set up, then, as follows:

$$f_p = \eta(\Delta W/W)(\Delta p/p)(\Delta V/V) \qquad (1)$$

where

η = propeller efficiency at V
ΔW = useful load
W = gross weight
Δp = maximum excess power
p = thrust power at V
ΔV = speed range (high speed minus stall speed)
V = high speed

This nondimensional factor resembles the efficiency factor for a heat engine, and the power curves are analogous to the pressure-volume diagram.

An airplane with $f_p = 1$ would have: (1) propeller efficiency equal to 1.0, (2) the entire gross weight would be useful load, (3) the drag would be zero so that all the power would be useful for climb and acceleration, and (4) the stalling speed would be zero so that the speed range would be equal to the high speed. Obviously, such an airplane cannot exist any more than a 100 per cent efficient heat engine can. For a light airplane of good performance f_p is of the order of 0.06. *The factor is applicable, of course, to an airplane of any type or class.*

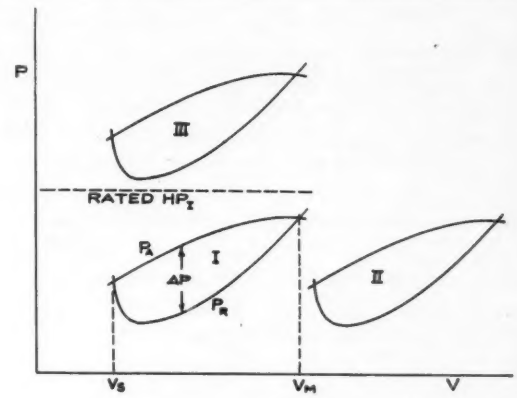

FIG. 2. Power curves for three hypothetical airplanes.

The maximum rate of climb is $R_c = 33{,}000\ (\Delta P/W)$. Using engineering terminology and placing $F_p = 33{,}000\ f_p$ and P/η = HP., Eq. (1) becomes

$$F_p = (L_u)(R_c)(V_m - V_s)/(\text{HP.})(V_m) \qquad (2)$$

where

L_u = useful load, lbs.
R_c = maximum rate of climb, ft. per min.
V_m = high speed, m.p.h.
V_s = stall speed, m.p.h.
HP. = rated engine horsepower

The nondimensional factor F_p is of more convenient size and is a factor that can be definitely determined from data obtained through routine flight testing. The factor f_p when equal to 0.06, as mentioned previously, becomes 1,980 when expressed as F_p.

The distinction between the usual reference to high performance and a high performance rating as represented by F_p should be noted. An airplane with high power and high speed may be referred to as a high-performance airplane but can have a lower F_p than an airplane with much lower speed. Thus, *F_p is a measure of the excellence of design rather than merely the result of high power.*

TABLE 1

(1) Performance aspects	
(a) Stall speed, power off	$5(40 - \lvert V_s - 40 \rvert)$
(b) Landing approach speed	$5(100 - V_a)$
(c) Wing loading	$10W/S$
(d) Take-off, ground run	$0.2(1{,}000 - d_g)$
(e) Take-off over 50 ft.	$0.1(2{,}000 - d_{50})$
(f) Angle of climb	$1{,}000 \sin \theta$
(2) Control at landing approach speed	
(a) Maximum sideslip	$20\beta \leq 200$
(b) Glide angle control	$1{,}000\ [\sin \phi_{(v_s + 2)} - \sin \phi_{v_s}]$
(c) Pitch control for flare out	$15(e_{max.} - e_{trim} + 10) \leq 150$
(d) Control forces	$10(10 - \lvert 10 - F \rvert)$
(3) Stall	
(a) Aerodynamic stall warning	$40(5 - \lvert 5 - V_s - V_w \rvert)$
(b) Abruptness of stall	
Chordwise	25 ($\Delta\alpha_{T.E.}$ stall to C_L peak)
Spanwise	25($\Delta\alpha_{inbd.}$ stall to C_L peak)
(c) Tip nonstall, complete stall	20 (per cent span from tip)
(d) Aileron control	$200[(C_l)_{v_s}/(C_l)_{v_a}] + 100$
Complete stall, corrected for adverse yaw	(zero for reversal)
(e) Adequate rudder control	200
(f) Altitude loss, complete stall (entry to recovery)	$200 - h$
(4) Spin	
(a) Time to enter	
From power-off stall	$25(t - 1)$
From power-on stall	$25(t - 1)$
(b) Recovery by release of controls	50
(c) Minimum altitude loss, entry to recovery	$0.5(500 - h)$
(d) Nonspin	500
(5) Landing gear	
(a) Conventional type	
Yaw control	
Rudder only	0
Steerable swiveling tail wheel (with individual brakes)	100
Ground handling, no flaps	0
With flaps	50
(b) Tricycle type	
Yaw control	
Nose wheel	
Steerable with ailerons	25
Steerable with rudders	50
Swiveling with individual brakes	100
Steerable, with rudders plus swiveling with individual brakes	200
Ground handling, with or without flaps	50
Flare out	25

Safety Rating Factor

The safety of an airplane is determined by many items. Unlike the performance, which is easily expressed in terms of quantities obtainable from comparatively simple flight tests, the safety involves the personal element of the pilot. This means that any quantitative measure of safety must be expressed statistically, the statistics being obtained from safety and accident records and from pilot experience.

The safety, in contrast to the performance, is influenced directly by certain design items. For example, reference to Eq. (2) shows that the performance factor is effected by the design parameters only indirectly through the resulting flight characteristics. On the other hand, the effect on safety of the type of landing gear, conventional or tricycle, must be determined directly in terms of safety statistics. For some items the expression can be either direct or indirect. Thus, in determining the amount of rudder required for adequate control in the stall, the value can be expressed indirectly in terms of a yawing moment coefficient or directly in terms of pilot experience. If the yawing moment coefficient method of expression is used, then the required values of the coefficient must be determined from flight test in the same manner as for the direct expression. It appears unnecessary, therefore, to include the intermediate step for such items.

With these considerations the safety scale of the rating chart, Fig. 1, is determined. In the interest of simplicity a weighted listing of items determining the safety is used. The items and the evaluations as applied to a personal-type light airplane are given in Table 1. Similar listings can be made for other types such as transport, military fighters, etc.

The weighting equations have been chosen to give a factor estimated to represent the safety in accordance with safety records. Considerable safety data, although not complete, were available to the author for determining the weightings used in the listing. Use of the listing given has shown, except for some minor items, that the weightings represent the safety sufficiently close for the purpose intended—namely, to serve as an aid in the development of better airplane and component design.

The safety rating factor, F_s, must be modified as new items affecting the safety are developed. The inclusion of new items such as castering main gear or new types of controls, for example, to Table 1 can be made when sufficient statistics are available to evaluate their effect on the factor, F_s. In addition, as given here, F_s can be used as a guide to indicate which items should be developed in the future in order to attain better safety.

It should be noted that certain performance items not considered directly in the performance rating factor are included as a definite part of the safety rating factor.

A complete discussion of the considerations leading to the evaluations given in Table 1 would be too lengthy to be included here. Only a brief summary is given to indicate generally the basis of consideration:

(*1*) *Performance Aspects.*

(a) The stall speed, if too low, is unsafe in gusts or cross winds. If too high, the pilot time reaction and judgment required during landing is greater than is safe for a pilot of limited experience and ability. Hence, the stall speed should be an optimum, which has been chosen as 40 m.p.h.

(b) The kinetic energy to be dissipated in a landing is a function of the square of the landing approach speed, V_a. Hence, a low stall speed with a dangerous stall that requires a high V_a is just as unsafe in practice, in regard to V_a, as an airplane with a correspondingly high stall speed and a good stall. The matters considered in (a) and (b) are most important for forced landings and small fields.

(c) A higher wing loading gives better ground handling in gusts and cross winds.

(d), (e), and (f) Comparatively short take-off and good angle of climb are important in reducing climbing stalls and accidents when taking off from small or poorly surfaced fields.

(2) *Control at Landing Approach Speed.*

(a) and (b) Sideslip and glide control are important in reducing landing judgment requirements, especially in dead-stick forced landings. The sideslip provides additional safety in cross-wind landings as well.

(c) Sufficient pitch control, to give landing flare out for all speeds within about 2 m.p.h. of V_s, for example, is an important safety item.

(d) Control forces must be low enough to eliminate fatigue but high enough to give good control feel.

(3) *Stall.*

(a) A definite aerodynamic stall warning about 5 m.p.h. above the stall is extremely valuable as a safety feature. It is the author's opinion that it should be entirely aerodynamic and not require any mechanical or electrical devices that can fail just when needed most.

(b) and (c) A gradual stall to prevent sudden loss of lift, and with the wing tips still flying, when the pitch control is full back, sufficient to provide damping in roll is necessary if the dynamic motions are to be damped and not violent.

(d) and (e) Positive aileron control in the stall and adequate rudder control to handle adverse yaw are extremely desirable. With this arrangement the control response is essentially the same in the stall as in the normal flight range. If the ailerons are ineffective at the stall, then adequate rudder must be available for lateral control.

(f) If recovery from a stall is performed simply and little altitude is lost, then the dangers in a stall are small.

(4) *Spin.*

(a) The time to enter the spin after the necessary control setting for entry has been made, is an important factor. This is approximately the time required for the first half turn after the control setting required is made and prior to the actual spin. If this time is comparatively long and there is adequate stall warning, a pilot of limited experience and capability can observe it and react soon enough to correct.

(b) Release of the controls to give recovery is a safety advantage.

(c) The altitude loss is usually high and is one of the dangers of a spin.

(d) The nonspin characteristic is a definite safety feature.

The rating as given here places more importance on good stall characteristics than on nonspin. The stall always precedes the spin, and, if the stall characteristics are simple and easy to handle, then the danger of entering a spin is greatly reduced. In any event nonspin is desirable.

TABLE 2

Airplane	A	B	C	D	E	Model 52	F
Performance	280	420	815	580	685	620	1,050
Control	150	375	475	225	475	450	675
Stall	200	200	400	850	700	1,175	1,250
Spin	100	100	250	500	375	375	500
Landing gear	0	150	100	100	150	275	275
Safety-rating factor	730	1,245	2,040	2,255	2,385	2,895	3,750
Estimated performance-rating factor	...	2,800	2,180	2,260	2,200	3,040	...

Model	Description
A	Hypothetical airplane with minimum CAR 03 approval
B	Low-wing, high-performance, two-place
C	65-hp. tandem trainer
D	Two-control with tricycle gear
E	High-wing, strut-braced, four-place, with conventional gear
52	Two-place, low-wing
F	Estimated maximum safety with present data

(5) *Landing Gear.*

The tricycle gear has a distinct advantage in the flare out and in safer handling in gusts and cross winds. It has a hidden disadvantage. The take-off is usually not so good because the effective maximum lift coefficient is less by twice the tail lift as compared to the conventional type. The use of flaps with the conventional type gives comparable safety for ground handling.

Table 2 indicates the relative importance of the group items as evaluated for seven representative model types. Included are one hypothetical model that has a minimum of safety features sufficient only to pass the CAR part 03. Also included are a representative two-place high-performance model, a light tandem trainer, a two-control model, a four-place spin-resistant model, the Bendix Model 52 (described later), and another hypothetical model representing approximately the maximum safety that can be designed on the basis of this evaluation, with present design information and with no regard to cost or performance.

The following are noted from Table 2:

(1) An airplane that barely passes the CAR 03 minimum requirements rates rather low on the scale.

(2) The rating scale provides a means of evaluating the relative safety merits of airplanes that have safety features exceeding the CAR 03 minimum requirements.

(3) On the basis of present information considerable improvement can be made in the safety of airplanes designed to date.

The safety features discussed pertain only to aerodynamic features including flight and ground handling characteristics. Obviously, many other items such as engine reliability, icing conditions, bad weather, cabin safety features, structural design, etc., must also be considered in their relation to the safety. These items are essentially separate and are not considered here.

The seven representative types listed in Table 2 are plotted on the chart in Fig. 1. The results of the use of analysis as presented here are indicated by the location of Model 52 on the chart.

Relation of Chart to Design

The rating chart, Fig. 1, provides a means for quantitative evaluation of the compromise between performance and safety. The rating factors through their relation to the design parameters and the corresponding position on the rating chart can be used to obtain a definite knowledge of the effect of each parameter on the resultant design. A chart position to the upper right as shown in Fig. 1 is desired.

Thus, rather than designing for performance (or safety) alone and accepting the safety (or performance) that results as an unavoidable consequence that can be only slightly improved by revision afterwards, it is possible to design for performance and safety as a unit.

The performance rating factor, F_p, given by Eq. (2) is a function of useful load, L_u, and engine rated power, HP. It is assumed that these are approximately determined by the class of airplane being designed. The effect of small changes in L_u and HP. are easily determined from the factors given in Eq. (2) and will not be discussed further.

The other items determining F_p are related to the design parameters as follows:

1. For a given engine, R_c, and hence F_p, is greater if the drag is less, and the propeller efficiency greater, at climb speed and if the gross weight is less. The actual relations are well known.

2. $(V_m - V_s)/V_m = [1 - (V_s/V_m)]$. Hence, F_p is greater if the ratio of stalling speed to high speed is less. The relation of this ratio to the design parameters is

$$\frac{V_s}{V_m} = \left(\frac{2W}{\rho S(C_L)_{max.}}\right)^{1/2} \Big/ \left(\frac{2\eta \text{HP.}}{\rho S(C_D)_{V_m}}\right)^{1/3} = \frac{(C_D)_{V_m}{}^{1/3}}{(C_L)_{max.}{}^{1/2}} \left(\frac{2}{\rho S}\right)^{1/6} \frac{W^{1/2}}{(\eta \text{HP.})^{1/3}} \quad (3)$$

where

ρ = air density
S = wing area
W = gross weight

Eqs. (2) and (3) give the relation of the design parameters to the performance factor F_p. It is noted that the value of $(C_D)_{V_m}$ or $(C_L)_{max.}$ alone does not specify the rating of an airplane or an airfoil but that the ratio as given must be considered. Also, greater wing area, higher rated power, higher propeller efficiency and lower gross weight all lead to higher F_p.

The performance aspects of the safety evaluation are all dependent upon the gross weight. All items except wing loading are improved by decrease in weight. In addition, the take-off distance is reduced by increase in the maximum lift coefficient (or decrease in the stall speed).

All other safety evaluation items are influenced by the type of stall, amount of control and type of landing gear as indicated in Table 1.

(III) Application to a Design Development

Application of the foregoing principles to development of an improved design is involved. Theoretically, a logical mathematical selection of the optimum design could be made. Restrictions imposed by other considerations such as cost, hangar space requirements, maintenance, etc., add further complications to the selection. Consequently, a more practical trial solution method was used.

The wing, being the most important component, is the focus of the development. The steps leading to an improved wing design are given, followed by an application to a two-place airplane.

Wing Design Considerations

A wing with elliptical span load with aspect ratio of 7.3 and an NACA 23015 airfoil section with 50 per cent span inboard flaps was used as a standard of reference for performance only. It is not considered as a usable design because of its low safety rating with its sharp stall peak and higher cost of production. It does have low drag, high maximum lift coefficient, and low pitching moment and, hence, has a high-performance rating in comparison with other designs with the exception of more recent laminar flow sections. (These were ruled out as impractical because of surface smoothness requirements.) *This low safety rating of the reference wing which accompanies a high-performance rating is typical.*

A high safety rating requires that the wing have a well-rounded maximum lift coefficient peak. This can be obtained by use of an airfoil section with a rounded lift coefficient peak and a rectangular plan form, and twist if necessary. Outboard leading-edge slots and inboard leading-edge spoilers can be used to help attain this result. Unfortunately, slots and spoilers reduce the ratio $(C_L)_{max.}/C_{D_V}$ and, hence, are not good from the performance standpoint.

On the other hand, airfoil sections with well-rounded stall peaks and a fairly high $(C_L)_{max.}$ are, in general, highly cambered and have high $(C_D)_V$ and high pitching moment coefficients. If the rounded peak is obtained by a comparatively sharp leading-edge radius, then the $(C_D)_V$ is low but the $(C_L)_{max.}$ is also low. *This comparatively low performance of wings with high safety rating is also typical.*

The question of use of flaps must be decided. If flaps are used, the ratio $(C_L)_{max.}$ (with flaps)/$(C_D)_V$ (without flaps) is increased. The importance of this characteristic must be weighed against the less desirable stall characteristic and the additional cost and weight.

A solution to this apparent dilemma, where high performance and high safety appear to be incompatible, was obtained in the following way.

Development of Wing No. 416

A highly cambered airfoil section was developed to have the desired maximum lift and stall characteristics. In addition it was developed to have the following

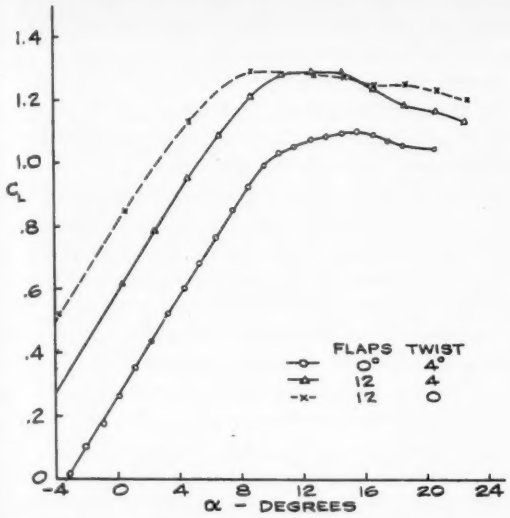

FIG. 3. Lift coefficient curves for wing No. 416.

characteristic: A flap incorporated in the trailing edge could, when it was deflected up (instead of down), essentially transform the airfoil into a low drag reflexed airfoil with low pitching moment.

This procedure, where the airfoil section, flaps, and aileron were designed as a unit with the airfoil designed for the flaps-down condition, is somewhat different from the usual procedure where essentially the airfoil is selected for the no-flap condition and the flap is added afterward.

A rectangular plan form was selected. Compared to an elliptical plan form, the induced drag at high speed is greater by only 0.3 per cent for the rectangular wing. With the well-rounded stall peak and full-span flaps described later, the decrease in maximum lift peak for the rectangular plan form is insignificant in terms of usable stalling speed.

Starting with the existing airfoil section data on highly cambered sections similar to those developed from the Joukowski series,[1] a section was developed which has the desirable characteristic of a highly cambered section with a well-crowned upper surface when the *flap is down*. When used with the rectangular plan form of aspect ratio 7.3, the $(C_L)_{max.}$ peak is as shown in Fig. 3. Four degrees of twist (washout at the tips) improved the peak further, as shown. The data were taken at a Reynolds Number approximately one-third full scale. Corrected to full scale, $(C_L)_{max.}$ equals 1.52 for the complete airplane trimmed.

The gradual progression of the upper surface local stall from the inboard trailing edge forward and out to the tips is shown in Figs. 4a–4d for the flaps-down configuration. The tuft photos show that the flow is separated from less than half the inboard part of the wing at the knee of the lift curve peak (10°) and only progresses to slightly over half the upper surface in 4° increase of angle of attack (to 14°) at the lift curve peak. At $\alpha = 22°$, or 12° above the knee, better than about

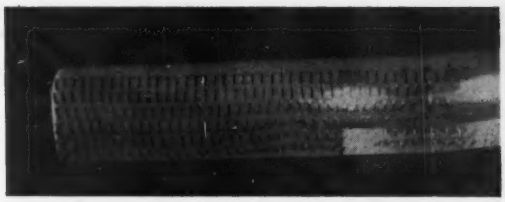

FIG. 4a. Angle of attack = 8°.

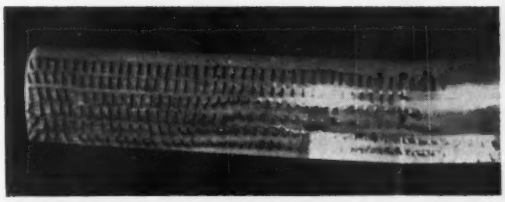

FIG. 4b. Angle of attack = 10°.

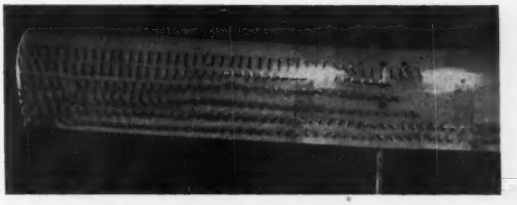

FIG. 4c. Angle of attack = 14°.

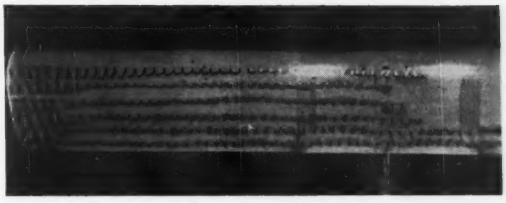

FIG. 4d. Angle of attack = 22°.

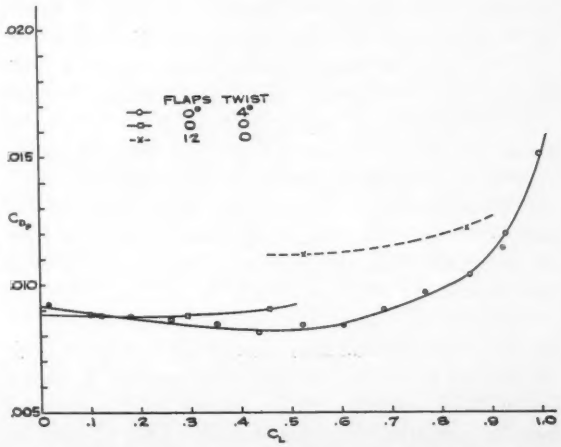

FIG. 5. Profile drag curves for wing No. 416.

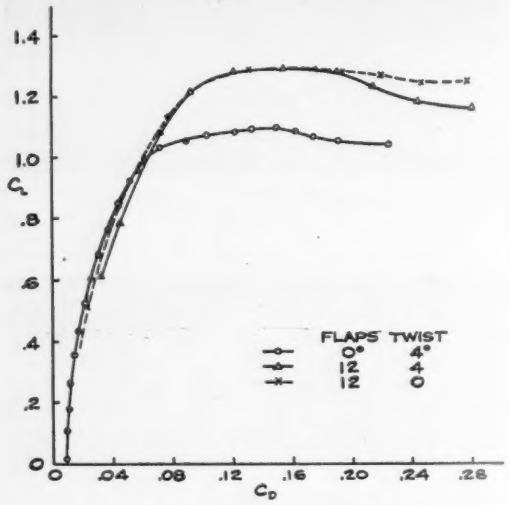

FIG. 6. Polar for wing No. 416.

15 per cent of the tip is still flying. The data were all taken in the 10-ft. wind tunnel at the California Institute of Technology in July, 1945.

The *flap*, when deflected *up*, essentially transforms the highly cambered airfoil to a reflexed airfoil with comparatively low drag and low pitching moment. It is noted from Fig. 5 that the drag at $V_{max.}$ or $C_L = 0.15$ has not been increased by the twist. Actually, the airfoil efficiency factor is approximately 1.15 so that the twist has reduced the drag at climb and glide speeds. The span-load distribution is more nearly elliptical for these conditions.

In addition, with the flaps in any position the drag remains normally low with increase in angle of attack until the lift curve starts to round off. On further increase in angle of attack the drag increases rapidly, as shown in Fig. 6. This provides glide control and stall warning as discussed later.

The large negative pitching moment coefficient characteristic of highly cambered airfoils is reduced to a small positive value by the flap retraction (Fig. 7). With the c.g. near 25 per cent M.A.C. this means there is little horizontal tail lift required at cruising speeds for balancing, so the tail induced drag is a minimum. Also the wing pitching moment coefficient data show the center of pressure change is small with increasing lift coefficient until stalling begins. With further increase in angle of attack the center of pressure moves rapidly aft with little change in lift coefficient. With this characteristic, comparatively little restriction of the pitch control is necessary in order to prevent overcontrol in the stall, and greater c.g. travel can be more easily handled.

With the flaps down, the airfoil is a highly cambered section with a smooth curve from leading edge to trailing edge on the upper surface. With flaps up, as shown in Fig. 8, it is an airfoil with a reflexed trailing edge and has the properties of a laminar-flow type of section. With this flap setting there is a sharp break at the flap on both the upper and lower surfaces. This break, the twist, and the comparatively thick section give the wing a characteristic appearance.

In order to make the best use of these sectional properties then a rectangular plan form with full-span plain-type flaps with sealed gap and 25 per cent of the chord was selected. The flap deflection is 12°.

Lateral Control.—The well-rounded stall peak of the airfoil section makes it possible to design aileron control that has positive roll control that operates in the normal manner when the wing is stalled, provided the adverse yaw can be kept sufficiently low.

This was accomplished by also using the spanwise flaps as ailerons. Since the aileron effectiveness per unit span length is nearly constant as far inboard as 70 per cent from the tip for a rectangular wing,[2] and with the large per cent chord of the sealed flaps, only small angular deflection of the flaps as ailerons is required. A differential with maximum deflection of 5° down and 8° up gives a lower adverse yaw and desirable wheel forces for all flap settings.

The use of the same surface for flap and aileron reduces the cost and complication.

Comparison to Elliptically Loaded Wing with NACA 23015.—When wing 416 was compared with the reference wing mentioned earlier, after careful correction of Reynolds Number, etc., the two combinations were found to have the same $(C_L)_{max.}/(C_D)_V$ ratio within the accuracy of the corrected data. Because of the excellent stall peak of the 416 wing, however, the usable ratio is greater for the 416. The 416 section has a

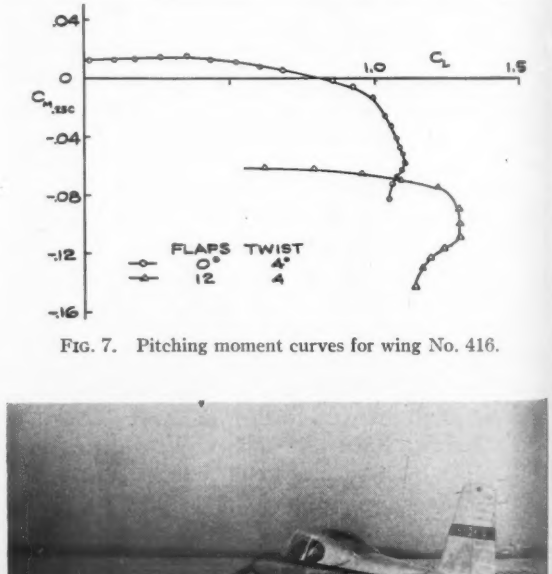

FIG. 7. Pitching moment curves for wing No. 416.

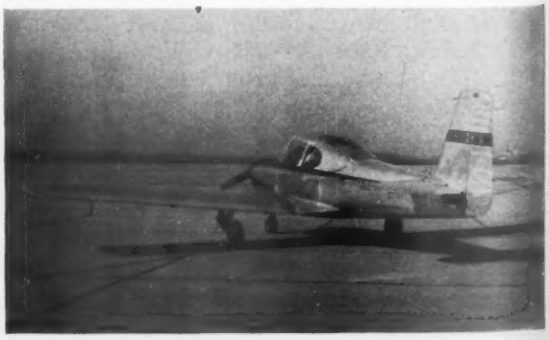

FIG. 8. Three-quarter rear view.

thickness ratio of 0.165 as compared to 0.15 for 23015. Hence, the 416 is also better structurally.

Application to an Airplane

The 416 wing was designed as an integral part of a small two-place tractor airplane known as the Bendix Model 52 shown in Fig. 8. Briefly, it has the following features: (a) 100 hp., starter, battery, radio, 25 gal. gas; (b) tricycle, partially retractible gear; (c) flight adjustable propeller; and (d) wing dimensions—(1) span = 33 ft. and (2) chord = 53 in.

The nose wheel is steerable through springs by the rudder pedals similar to the way tail wheels are steerable on most small airplanes. This system is extremely easy and safe to handle in heavy cross wind landings and taxiing. Individual toe brakes make it easier to handle in restricted places.

The installation of the wing on Model 52 necessitated a small modification in the nature of a reflex to take care of fuselage interference.

Performance.—The performance corrected to standard sea-level conditions is

High speed (true)	146 m.p.h.
Stall speed (true)	52 m.p.h.
Glide speed	70 m.p.h.
Maximum rate of climb	900 ft. per min.
Useful load	525 lbs.
Gross load	1,550 lbs.
Take-off over 50 ft.	1,100 ft.

The speed calibration was made over a 4.6-mile course. The performance rating factor is 3,040 as shown in Fig. 1.

The airplane has the conventional three controls with a wheel for lateral control. The rudder makes possible a slight improvement in a coordinated turn for speeds below 90 m.p.h. It is most useful for cross-wind landings and sideslip. With the rudder fixed, the airplane handles as an excellent two-control nonspin type.

Stall Characteristics.—The *power-off stall* is very stable. With the pitch control held all the way back and the lateral controls fixed in neutral, the nose slowly drops and a stable, fairly steep glide is established. The lateral and longitudinal motions are stable and well damped with no oscillation, divergence, or tendency to drop a wing. All controls are just as effective in the stall as at normal flight speeds except the roll control. This is reduced to about half or has C_l equal to about 0.01. There is excellent stall warning about 4 or 5 m.p.h. above the stall speed, and when the airplane is nearly stalled, the tail and controls are shaking sufficiently so there is no question that the airplane is near the stall.

In a *power-on stall* the angle of attack is higher than for an airplane with a more conventional wing, and the control effectiveness is approximately the same as for a power-off stall. With the lateral controls fixed in neutral and the pitch control all the way back, the airplane slowly pitches nose down. If a wing drops, it can be rolled back to level flight by normal use of aileron and rudder, the proportion of rudder being more than for normal flight just above the stall speed. If the controls are kept fixed when a wing drops, then the airplane will sideslip and automatically pick the wing up, and a lateral motion similar to a Dutch roll will be established. The amplitude will stabilize at 15°–30°, depending on the c.g. position.

It must be emphasized that this oscillation occurs well beyond the maximum lift peak when the airplane is completely stalled without restricted elevator control. When a limitation is imposed on the elevator travel, as is done on some airplanes, the oscillation is avoided. Only a small elevator limitation is required. The oscillation is not dangerous, however, and, as indicated from Table 1, the greater elevator control is considered a better safety feature.

Actually, in the case of more conventional designs when this maneuver is performed and a wing drops, unless it is picked up by skillful use of the rudder, the airplane will enter a spin. Thus, the Model 52, with the oscillation and adequate lateral control to prevent it, is a decided improvement.

Minor changes in directional or lateral stability made no appreciable change in the oscillation. Large changes might possibly eliminate it, but the oscillation was not considered dangerous, so larger changes were not deemed worth while. The oscillation is readily stopped by easing forward on the pitch control.

The *power-on stall* in a moderate or a *steep turn* has the following unusual safety characteristic. As the airplane enters the stall with the pitch control all the way back, it automatically rolls out to level flight and stops there. It does not continue to roll over to the opposite bank and into a spin as will occur with a more conventional design, unless the pilot is fast on the controls and drops the nose by moving the stick rapidly forward. This roll out of a stalled turn also occurs against full aileron and rudder control.

It should be noted that these stall characteristics on the airplane as described are obtained *without the use of wing tip slots or spoilers* of any kind.

Glide Control and Stall Warning.—The wing as installed on Model 52 provides an effective glide control. It starts at 65 m.p.h. and increases to a maximum at the lift curve peak as the speed is reduced to 52 m.p.h. In this speed range the angle of glide can be increased about three times without passing beyond the maximum lift peak. About 4 or 5 m.p.h. above stall speed there is a definite (but not serious or violent) shaking of the control wheel giving the pilot excellent warning of the approach of the stall. *Thus a definite stall warning, which is readily recognized by any pilot, is obtained by proper aerodynamic design.* It does not require the use of auxiliary equipment that is susceptible to failure.

The glide control is usable because (1) the forward speed change is small and the pilot can recover back to a lower glide angle quickly with comparatively little loss of altitude by easing forward on the stick. (2) There is still additional lift coefficient available after the stall warning is observed for a flare out if recovery

(*Continued on page 84*)

A Pneumatic Method for Measuring High-Temperature Gases

DAVID WILLIAM MOORE, JR.*

Fairchild Camera and Instrument Corporation

Introduction

The measurement of high gas temperatures has always been a severe problem but, until recently, not one of any great importance to the aircraft industry. However, with the advent of the turboprop, turbojet, ram-jet, rocket, and similar power plants, the measurement of high gas temperatures has become a problem of major magnitude. It has become important both for the purpose of securing adequate design data and of enabling accurate, economical, and safe flight control. It is well known that the turboprop engine cannot be safely operated without accurate measurement and control of combustion chamber temperatures. If these temperatures exceed certain limits, the power plant, as well as the air frame in which it is installed, may be destroyed. This paper will discuss a method of measuring these high gas temperatures that we have been developing and which we feel will be of general interest and of practical operational use.

The gas temperatures that have to be measured range from a maximum of perhaps 2,500°F. for turboprop installations to more than 8,000°F. for various rocket propulsion systems. Afterburning in conventional jet engines and ram-jet power plants produce operating temperatures in excess of 3,500°F. So we find ourselves at the present time with power plants suitable for flight operation having burner temperatures that cannot be conveniently measured by any conventional means.

Problems in Accurate Measurement

There are many problems to be solved in the accurate measurement of these gas temperatures. The sensitive element must stand up under both oxidizing and reducing atmospheres. When the sensitive element has been suitably protected to ensure a sufficiently long service life, its speed of response has usually been so reduced that its practicality has been greatly restricted.

Then there is the question of radiation. The errors from this source rapidly increase with rising temperatures. Various forms of shielding have reduced this type of error to reasonable values in some applications, but in many cases it is still a major source of error.

For control purposes the speed of response to temperature transients is essential. Things happen so fast in these new types of power plants that a sluggish temperature control would seriously affect the stability of the system. Response rates of less than 1 sec. are required for practically all applications, and temperature-measuring systems that are not capable of this speed will find little control use.

In burner installations there is always danger of unburned, or burning, liquid fuel depositing on the temperature-measuring element. If this sensitive element happens to be a thermocouple, the resulting error is extremely serious. The temperature-measuring system should, insofar as possible, not be affected by fuel deposits or by contamination by lead, sulphur compounds, etc.

Of course, it is also highly desirable that the system used does not require a laboratory full of equipment or the presence of an operator in the vicinity of a burner that may or may not explode. It should be simple in operation and capable of being used for flight operation in the control of various forms of power plants.

When this problem of measuring high temperature gases was presented to us, we sought a solution that would be capable of either solving or at least minimizing the difficulties mentioned and one that could be developed to a point where it would be useful to the industry with a minimum of expense. The system of measuring high temperature gases which will be described is rapid, substantially free from radiation effects, and sufficiently accurate for most applications. When fully developed it should be capable of continuous operation in practically any type of combustion chamber.

Discussion of the Method

The operation of our method of measuring high gas temperatures is based upon the well-known equations concerning the flow of gas through an orifice, equations that have been carefully determined. Using these equations, the flow of gas through an orifice may be calculated once the flowing pressure and temperature of the gas is known, together with the differential pressure drop across the orifice and the orifice calibration. The accuracy of this method of flow measurement has been well established and universally accepted.

Now, if in a similar system we know the flow of gas through the orifice, together with the flowing pressure, the orifice calibration, and the differential pressure drop, we find we can calculate the flowing gas temperature. This calculation of temperature will be inherently of a

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* Engineer in Charge.

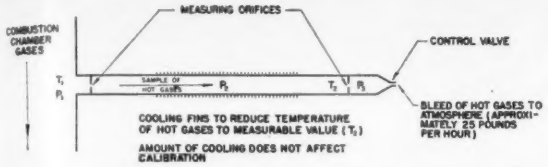
MEASURING ORIFICES
COMBUSTION CHAMBER GASES
CONTROL VALVE
SAMPLE OF HOT GASES
COOLING FINS TO REDUCE TEMPERATURE OF HOT GASES TO MEASURABLE VALUE (T_2)
AMOUNT OF COOLING DOES NOT AFFECT CALIBRATION
BLEED OF HOT GASES TO ATMOSPHERE (APPROXIMATELY 25 POUNDS PER HOUR)

FIG. 1. Fairchild temperature-measuring system.

high order of accuracy and will hold as long as the gases being measured substantially follow the true gas law characteristics.

This use of a simple orifice to measure temperature, employing well-known flow equations, is the basis of our high gas temperature measuring system. In actual operation, a sample of the hot gases to be measured is drawn from the combustion chamber and passed through an orifice, as shown in Fig. 1. This sample of hot gases is then cooled and passed through a second orifice and then through some form of reducing nozzle to atmosphere. The use of two orifices greatly simplifies the calculations, since such variables as the amount of sample gas flowing cancel out and do thus not need to be measured or controlled. From the following calculations:

$$W = C_1 A_1 \sqrt{\frac{(P_1 - P_2)P_1}{T_1}} = C_2 A_2 \sqrt{\frac{(P_2 - P_3)P_2}{T_2}}$$

Therefore:

$$T_1 = \left(\frac{C_1}{C_2}\right)^2 \left(\frac{A_1}{A_2}\right)^2 \frac{(P_1 - P_2)P_1}{(P_2 - P_3)P_2} T_2$$

Since the orifice areas are substantially constant, and the orifice constants assumed fixed and since $(P_1 - P_2)$ can be made small so that P_2 in effect equals P_1:

$$T_1 = KT_2[(P_1 - P_2)/(P_2 - P_3)]$$

where

T_1 = temperature at first orifice
T_2 = temperature at second orifice
C_1, C_2 = orifice constants
P_1, P_2, P_3 = absolute pressure within system
W = mass flow of gas through the system.

It is evident that the ratio of the temperatures at the second orifices is equal to the ratio of the differential pressure drops across the two orifices. Thus, to determine the temperature of a hot gas, a sample of it is passed through the system, and the temperature at the second orifice, which will approach ambient, is measured, together with the ratio of the two differential pressure drops across the two orifices. By multiplying the temperature at the second orifice by the ratio of the two pressure drops, an indication of the desired hot gas temperature is obtained.

Since the first orifice in this system does not have to operate at the flowing gas temperature, the effects of radiation are small, being only the losses incurred from the radiation from the gas itself to the walls. This is a much smaller effect than that obtained from any form of temperature sensitive element such as a thermocouple or resistance bulb, which must operate at the gas temperature.

Since the pressure drop across the orifices is purely a function of the density and volume of the gas flowing through the system, the overall speed of response is great. This is so because the density of a gas changes simultaneously with temperature. The instant the density of the hot gases changes at the first orifice, the pressure drop across that orifice must change. This speed of response will usually be greater than the response of the means used to measure the value of the differential pressure.

In some installations the response of the system may actually be made to lead temperature transients, in effect producing a derivative response that is useful for stabilizing control systems in which temperature is one of the major parameters.

Any contamination or burning of the first orifice becomes a service problem and must be handled by periodic checking and replacement or cleaning. Tests we have run to date show no evidence of serious orifice contamination. However, much more extensive tests will have to be run to determine the effects of continuous operation.

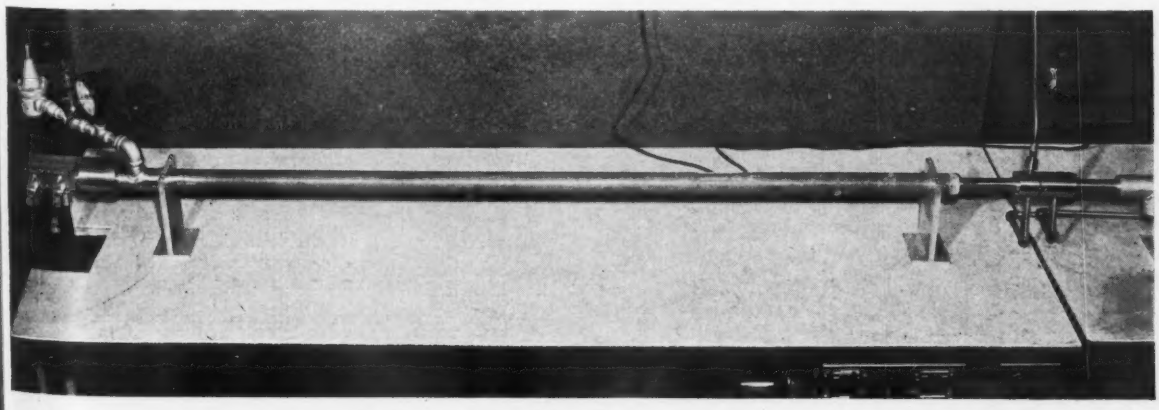

FIG. 2.

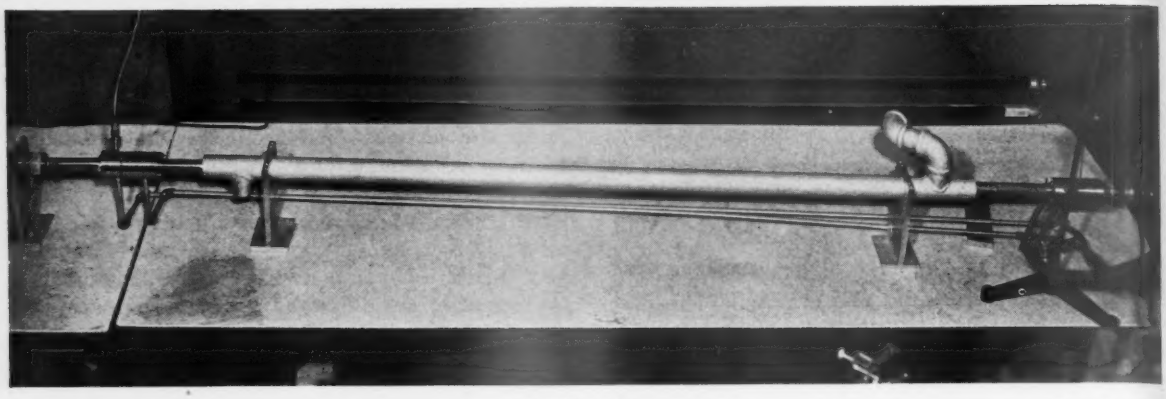

FIG. 3.

TESTS AND RESULTS

Our preliminary tests on the basic system were made on the equipment shown in Figs. 2 and 3. The hot gas sample was obtained by passing air through a nichrome tube approximately 6 ft. long. This nichrome tube was heated by passing through it a sizable current from a welding transformer. After the gases were heated they were passed through the first orifice, then cooled and passed through the second orifice. This provided the necessary components and permitted a fair amount of flexibility. The results obtained from this equipment are shown graphically in Fig. 4 and confirm the theory of operation well within the estimated accuracy of measurement. The boxes on the graph are an estimation of the order of accuracy of the measurements. It may be seen that the ratio of the differential pressure drops across the two orifices closely follows the ratio of the absolute temperatures at the two orifices, as was expected.

However, to supply a useful instrument and to fulfill the need for high gas-temperature-measuring equipment, it was necessary to design practical measuring systems using this basic relationship as a starting point. One of the first urgent applications for this method of measurement was the turboprop power plant, where it was necessary to obtain an output signal capable of feeding into an overall control system. To enable as much simplicity as possible, the basic system was so handled that it is only necessary to measure the differential pressure drop across the first orifice to obtain an indication of the combustion chamber gas temperature. To do this, it is necessary to maintain a constant differential pressure drop across the second orifice by means of a suitable proportional flow regulator and also to maintain a constant relationship between the gas temperature at the second orifice and the square of the effective orifice area. The following relationships show the manner in which this may be done:

$$T_1 = \left(\frac{C_1}{C_2}\right)^2 \left(\frac{A_1}{A_2}\right)^2 \frac{(P_1 - P_2)P_1}{(P_2 - P_3)P_2} T_2$$

and by assuming constant orifice coefficients, and that P_1 is substantially equal to P_2:

$$T_1 = \left(\frac{A_1}{A_2}\right)^2 \frac{(P_1 - P_2)}{(P_2 - P_3)} T_2$$

and if $(P_1 - P_2)$ is regulated so that it is constant, and the ratio of $T_2/(A_1)^2$ held constant, together with a constant A_1

$$T_1 = K\,(P_1 - P_2)$$

The area of the second orifice is varied as a suitable function of the temperature at the second orifice by means of a bimetallic strip and tapered plug arrangement.

A complete measuring system of this type is shown in Fig. 5. The components shown consist of the regulator, indicator, and temperature sensing probe. The temperature indicator is, in this case, a commercially

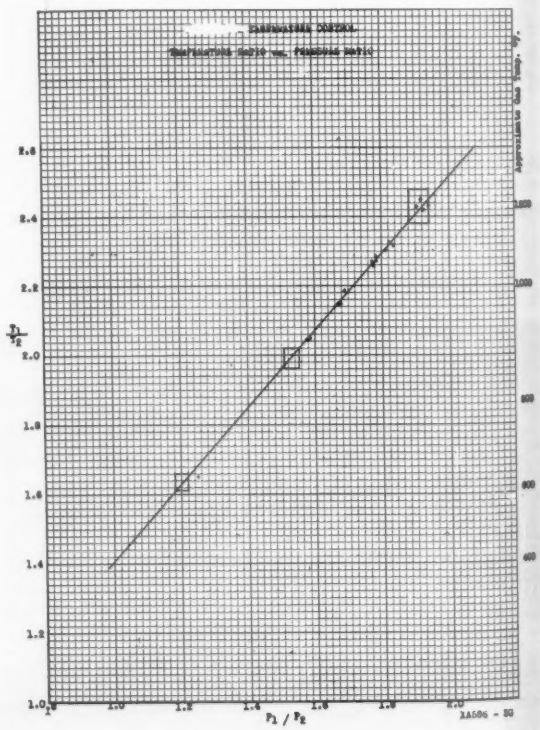

FIG. 4.

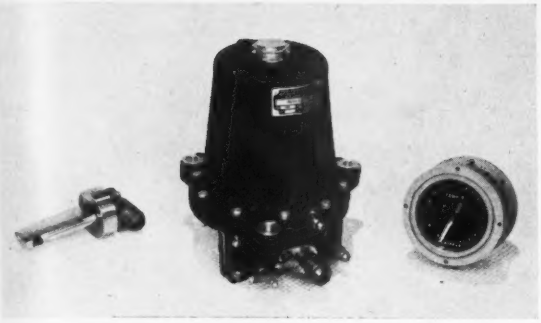

FIG. 5. Fairchild temperature indicator unit XB586-B1.

available indicator suitably calibrated in temperature. This particular instrument has a differential pressure output of 11 in. of water at 500°F. and 30 in. of water at 2,000°F. Thus, sufficient output force is available to directly operate a pilot valve on a fuel flow control system.

The probe for obtaining the sample of hot gases from the combustion chamber must be designed for the particular application in which it is to be used. The pickup shown was intended to be mounted on the J-33 and similar power plants. The constructional features of this probe may easily be seen in the cross section shown by Fig. 6. The measuring orifice is mounted as close as practical to the hot gas inlet to minimize cooling of the gases before they pass through the orifice. The P_1 pressure connection is made by means of an annular opening that enables an accurate determination of the static pressure ahead of the first orifice. The housing and orifice are fabricated from Vitallium to ensure adequate service life. This probe is designed to be mounted in front of the nozzles in a J-33 combustion chamber, so that turbine inlet temperature conditions may be accurately determined.

The characteristic speed of response of this system has been established at less than 1 sec. However, when it is installed on a jet burner, the response to a temperature transient is interesting. In a jet burner there is always a pressure increase with any temperature increase, and this pressure increase causes an excess of hot gases to flow through the system until the regulator has responded and made the necessary flow reduction. Before the regulator has responded, however, the temperature-measuring system will read high because of this increase in burner pressure. Since the response of the regulator is not instantaneous, the temperature indications will always lead a temperature change and, in effect, produce a desirable derivative action. This derivative action may be controlled to provide suitable damping for any control system in which it is installed by designing the regulator to have the proper time constant.

LABORATORY AND TEST STAND APPLICATION

While the measurement system just described is well suited to flight operation and to the incorporation in various control systems, it is unnecessarily complicated and expensive for laboratory applications. The following modification has been worked out for routine laboratory and test-stand application and is shown schematically in Fig. 7. The same basic elements are used, but the pressure drop across the second orifice is regulated manually to maintain a fixed relationship to the gas temperature at the second orifice. When this is done, the pressure drop across the first orifice is again an indication of the hot gas temperature and may be applied to a suitable differential pressure gage. The relationships for this version of the instrument are as follows: assuming,

$$T_1 = K_1 T_2[(P_1 - P_2)/(P_2 - P_3)]$$

then if the ratio

$$T_2/(P_2 - P_3)$$

is held constant by manually adjusting the flow of gas through the system,

$$T_1 = K_2(P_1 - P_2)$$

These laboratory instruments are currently being delivered with water cooled probes for measurements above 4,000°F. These probes have iridium first orifices and enable rapid measurement of these extreme temperatures.

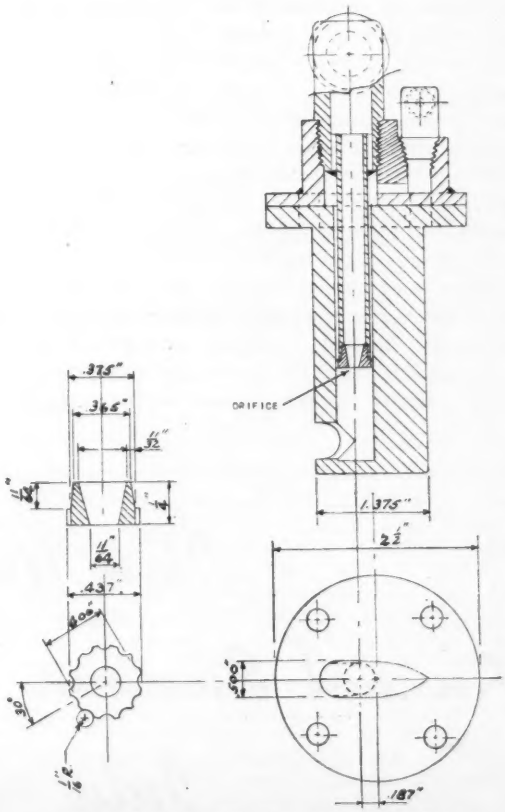

FIG. 6. Details of Vitallium probe and orifice.

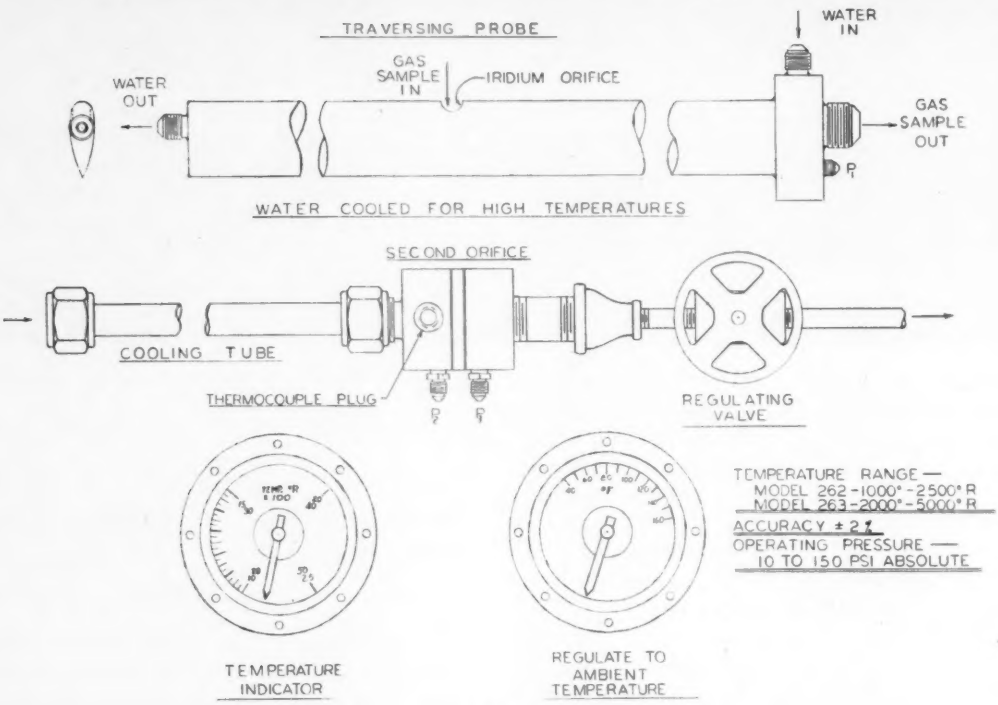

FIG. 7.

CONCLUSIONS

While these instruments have been constructed and have been and are currently being tested at various laboratories, there are still some problems to be overcome. One of the most serious associated with a high gas temperature measurement system such as this is the obtaining of the actual calibration of the instrument, particularly at temperatures in excess of 2,000°F. It is surprising how little equipment is available for measurement at these temperatures until an effort to obtain calibration facilities has been made.

Work must also be done to determine the pressure limits through which an instrument of this type may be accurately operated. Higher pressures impose no problems other than those of obtaining sufficient structural strength. Lower pressure, such as may be obtained in jet tail cones at extreme altitudes, require careful consideration and proper system design. Obtaining satisfactory regulator operation in the presence of the various products of combustion has given some trouble, but proper material selection to prevent corrosion should correct any problems.

Test results to date have been encouraging and indicate that accuracies within 1 per cent of the absolute temperature may be obtained. We feel that, although the possibilities and limitations of this system for measuring high gas temperatures have not been completely investigated, the development has progressed to the point where instruments suitable for laboratory and test flight operation, as well as for incorporation into experimental temperature control systems, can be supplied.

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I.A.S. Briefs

Summaries of current papers received for publication or presentation at I. A. S. meetings

Experimental Study of Cooling by Injection of a Fluid Through a Porous Material

By

Pol Duwez and H. L. Wheeler, Jr.

California Institute of Technology

A method of coping with the high rates of heat transfer encountered in the field of jet propulsion consists of making the parts to be cooled of a porous material and forcing the cooling fluid through the pores in a direction opposite to that of the heat flow. This method is referred to as "sweat-cooling." The study of sweat-cooling heat transfer discussed in this paper has the limited objective of defining the variables involved in the problem and of establishing the experimental techniques. A full description of these techniques is given. Extensive tables and graphs of the data which have been obtained are also given. This experimental study of sweat-cooling has shown that either a liquid or a gas may be used efficiently as a cooling fluid. A theoretical expression is derived relating the surface temperature of the porous material, the weight flow rate of the coolant, and the temperature and weight flow rate of the main stream of hot gas. The validity of this expression is discussed on the basis of the experimental data that have been obtained.

The Flow of a Perfect Fluid Through an Axial Turbomachine with Prescribed Blade Loading

By

Frank E. Marble

California Institute of Technology

The theory of the three-dimensional flow through an axial turbomachine, associated with variation of circulation along the blade length, is described as an extension of the classical theory of finite wings and is simplified to a problem in axially symmetric rotational fluid motion by considering an infinite number of blades in each row. The problem is linearized by considering the vorticity generated by the blades to be transported by the mean velocity.

The linearized problem leads to well-known partial differential equations and is solved for the tangential, radial, and axial velocity components associated with a single row of stationary or rotating blades with finite chord and prescribed loading. The particular case where the blade chord approaches zero is associated with the theory of the Prandtl lifting line for finite wings. Because of the linearity of the problem the solution for a multistage turbomachine follows by superposition of appropriate single rows.

The complete analytical expressions and graphical results for the velocity components are given for the case of a single blade row of given loading, with a hub/tip ratio of 0.6, blade aspect ratio of 2, and for stationary and rotating blades. The corresponding lifting line approximation is compared with the more nearly exact solution and is shown to constitute a useful approximation to the solution for a finite blade chord when the aspect ratio is large and when the lifting line is located appropriately.

A rough approximation for the axial velocity variation, deduced from the analysis, allows rapid estimation of the rate at which the equilibrium axial velocity profile develops ahead of, and behind, a blade row and, using the superposition principle, provides a simple means of approximating the axial velocity distribution in a multistage turbomachine and of discussing mutual interference of blade rows.

All papers abstracted in this issue were presented at the Flight Propulsion Meeting of the Institute, March 19.

Many of these papers, after being processed by the Editorial Committee in the usual manner, will appear in full in later issues of the *Journal* or *Review*.

Please see page 68 for preprints that are immediately available.

Service Experience with Turbojets

By

J. W. Bailey

Allison Division, General Motors Corporation

The turbojet engine, by comparison to other military power plants, has experienced some "growing pains" in its short development period, yet it has, in only 3 years of actual service use, proved to be a practical and reliable aircraft engine. It is extremely important, under a peacetime economy reflecting limited military development funds, that the service experience of engines of this type be fully utilized as an important phase of the development program of the turbine-type engine. Seventy-five thousand flying hours with the J-33 turbojet engine, like any new power plant, have not been accomplished without some difficulty. Such troubles as turbine wheels, compressor impellers, tail cones, and fuel controls occurred in the early models, but the lessons learned by the resulting investigation applied to production processing and operating instructions have reduced such difficulties to a minimum. Part difficulties found at engine overhaul are

for the most part repairable, which is reflected in a much lower part usage factor than is common to conventional-type engines. The J-33 has established an enviable service record, which is representative of a sound basic design and the continued incorporation of design improvements under conditions of utmost cooperation from the aircraft industry and the Armed Forces.

An Evaluation of Engine Design Compromises

By

Neil Burgess

General Electric Company

It has been pointed out by other authors that the aircraft gas turbine is simple relative to the reciprocating engine, thereby permitting rapid development.

In the development of present production turbines, a conservative thermodynamic and mechanical design has generally been employed in order to permit production of the turbine soon enough so that it would have tactical value. This approach has aided in the rapid evolution of the turbine.

The principal factor dictating use of the conservative design has been the shortage of full-scale component research test data. In addition, the mechanical designer has not yet learned to exploit to their fullest potentialities the available high-temperature materials.

Now that research data are becoming available from the component tests of the various engine manufacturers and Government facilities, it may be expected that a higher degree of thermodynamic and mechanical refinement will be incorporated in future designs. Although marked improvements in performance and operating life will result, the development cycle of these engines will be substantially longer.

Layout and Preliminary Design Problems

By

Milton U. Clauser

Douglas Aircraft Company, Inc.

The accelerated development of new power plants has extended the designer's horizon. It appears that there is a fundamental compromise in these engines of simplicity versus efficiency—i.e., specific weight versus specific fuel consumption. In installing the power plant in the airplane, the location of the pilot, power plant, and fuel involve further compromises in drag and ram, weight, and accessibility.

Safety, of course, must not be sacrificed. A combustion chamber in the middle of the airplane presents a major problem. The high-pressure, high-flow fuel systems require further development to obtain satisfactory reliability.

The slender shape of the engines and their attachment to long ducts and tailpipes defies installation in the traditional manner. This indicates that fads will come and go before a "conventional" arrangement for jets emerges.

Air Inlets and Nacelles

By

William J. Blatz

McDonnell Aircraft Corporation

In this paper the various factors affecting the aerodynamic performance of an air induction system are reviewed, and detail design points are discussed. Air inlets are divided into several basic types that are evaluated with regard to both aerodynamic efficiency and overall design simplicity. It is pointed out that with the improvement in aircraft performance made possible by the turbojet engine, the relative importance of duct efficiency has increased. Therefore it is predicted that the design trend will probably be toward greater structural and design complexity in the attainment of satisfactory air inlet performance.

Since considerable advantage from an air induction standpoint is to be realized in a nacelle installation, a short discussion is included on the design of nacelles for high-speed aircraft.

Design of Turbojet Exhaust Systems

By

Herbert C. Towle, Jr.

Republic Aviation Corporation

The P-84 Thunderjet fighter airplane presented problems in the design of the exhaust system of its turbojet engine which may be considered typical of a gas-turbine installation. The fuselage structure was protected from the high exhaust-gas temperatures by a cooling air that flowed between a stainless-steel shroud and the hot surfaces of the power plant. This method presented less fire hazard than the blanket type of insulation.

A flexible joint between the tailpipe and the tail cone was designed in which the normal tension loads were carried through four pins and load-distributing straps. While this design has functioned satisfactorily, it may concentrate loads as high as 5,000 lbs. on one or two pins, thus introducing unsymmetrical loads into the tail cone. Attempts to design a ball joint that would reduce the unsymmetrical loads were abandoned because of the excessive weight and cost involved. The modification of the tailpipe area which is required during the life of the engine was accomplished by the use of inserts rather than by trimming the tailpipe itself.

The Two-Stroke Compression-Ignition Compound Engine

By

A. E. Biermann and M. J. Tauschek

Flight Propulsion Research Laboratory, N.A.C.A.

This report covers an analysis of the performance potentialities of a compound engine comprising a two-stroke cycle compression-ignition engine, a compressor, and a gas turbine. Specific fuel consumption, specific output per cubic inch of engine displacement, and specific weight are used as the criteria for judging the potentialities of the engine. Turbine-inlet temperatures and peak cylinder pressures are considered as the chief mechanical limitations. The effects of component characteristics on the overall performance of the engine are presented.

For constant turbine-inlet temperature and constant cylinder pressure, the analysis indicates desirable regions of manifold pressure. An increase in allowable cylinder pressure is found to be effective in improving both the specific fuel consumption and the specific output. An increase in turbine-inlet temperature improves the specific output but has little effect on fuel consumption. The efficiencies of components such as the compressor, the engine, and the turbine have an appreciable effect on the specific output of the com-

plete engine but have little effect on the specific fuel consumption. The analysis indicates favorable altitude characteristics.

Accessory Equipment in Turbojet Installations

By

F. H. Sharp

Consolidated Vultee Aircraft Corporation

In the design of turbojet-powered aircraft, the accessory equipment for which the air-frame manufacturer is responsible is considered as an integrated system.

It appears desirable to consider a remote mounted accessory system to relieve congestion in the power-plant nacelle. A substantial weight-saving is also desirable.

To accomplish this, an auxiliary power unit, in conjunction with bleed air from the turbojet engines, drives all of the continuous and semicontinuous duty accessories through the medium of low-pressure high-flow air.

The proposed system is applied to the design of a large turbojet-powered aircraft of the water-based type and is aimed at stimulating interest in the development and use of low-pressure pneumatic-operated equipment for its low weight and installation flexibility features.

The Turbojet Engine

By

Reece V. Hensley and Newell D. Sanders

Flight Propulsion Research Laboratory, N.A.C.A.

The results of an analysis of the performance potentialities of the turbojet engine are presented. The effects of component efficiencies, compressor pressure ratio, turbine-inlet temperature, and air-handling capacity of the engine on the power and fuel consumption are discussed.

Improvements in component efficiencies will result in no significant improvement in thrust or economy. Fuel economy can be greatly improved by use of high compression ratios; at a turbine-inlet temperature of 2,000°R., raising the compression ratio from 4 to 18 lowers the fuel consumption 30 per cent with no reduction in thrust. The most effective means of increasing the output of a given size of engine is increasing the air-handling capacity and increasing the allowable operating temperature. The analysis indicates that it is possible to double the present air capacity per unit of frontal area and thereby double the thrust. At 500 m.p.h. and 30,000-ft. altitude, increasing the turbine-inlet temperature from 2,000° to 3,000°R. increases the thrust 60 per cent and increases the fuel consumption 10 per cent.

The Gas-Turbine-Propeller Engine

By

Robert O. Bullock and Robert E. English

Flight Propulsion Research Laboratory, N.A.C.A.

An investigation is made of the potentialities of the turbopropeller engine. The variation in the performance of the perfect cycle with the number of compressor stages and the turbine-inlet temperature is determined. Calculations are then made to determine the successive deviations in the performance of the engine occasioned by: (1) the use of air and the products of combustion of a hydrocarbon fuel as the working fluid; (2) the inefficiency of the compressors, burners, and turbines; and (3) the use of cooling to permit operation at ultrahigh turbine-inlet temperatures. The performance of a turbopropeller engine embodying turbine cooling is then investigated for an altitude of 30,000 ft. and a flight speed of 400 m.p.h.

The effects of the inefficiency of the engine components are generally reduced as the turbine-inlet gas temperatures are increased. Although the greatest benefits of increased gas temperatures at the turbine inlet appear as increases in engine power per unit engine size, significant improvements in economy result from the permissible use of increased cycle pressure ratios. The losses occasioned by the application of liquid-cooling to the blades is small in comparison to the performance improvements resulting from the higher temperatures permitted at the turbine inlet.

The Four-Stroke Spark-Ignition Compound Engine

By

Leroy V. Humble and Cecil G. Martin

Flight Propulsion Research Laboratory, N.A.C.A.

An analysis was made of the performance potentialities of a compound engine comprising a four-stroke cycle spark-ignition engine, a compressor, and a gas turbine. The effect of engine compression ratio, fuel grade, engine exhaust pressure, and altitude on net mean effective pressure, specific fuel consumption, and specific weight is considered.

The analysis indicates that reducing the compression ratio results in a marked increase in net output as limited by knock, with a relatively small increase in specific fuel consumption.

Improvement in engine, turbine, and compressor efficiency results in substantial gains in net output and specific fuel consumption. Specific weight decreases as compression ratio is decreased. The analysis indicates favorable altitude characteristics.

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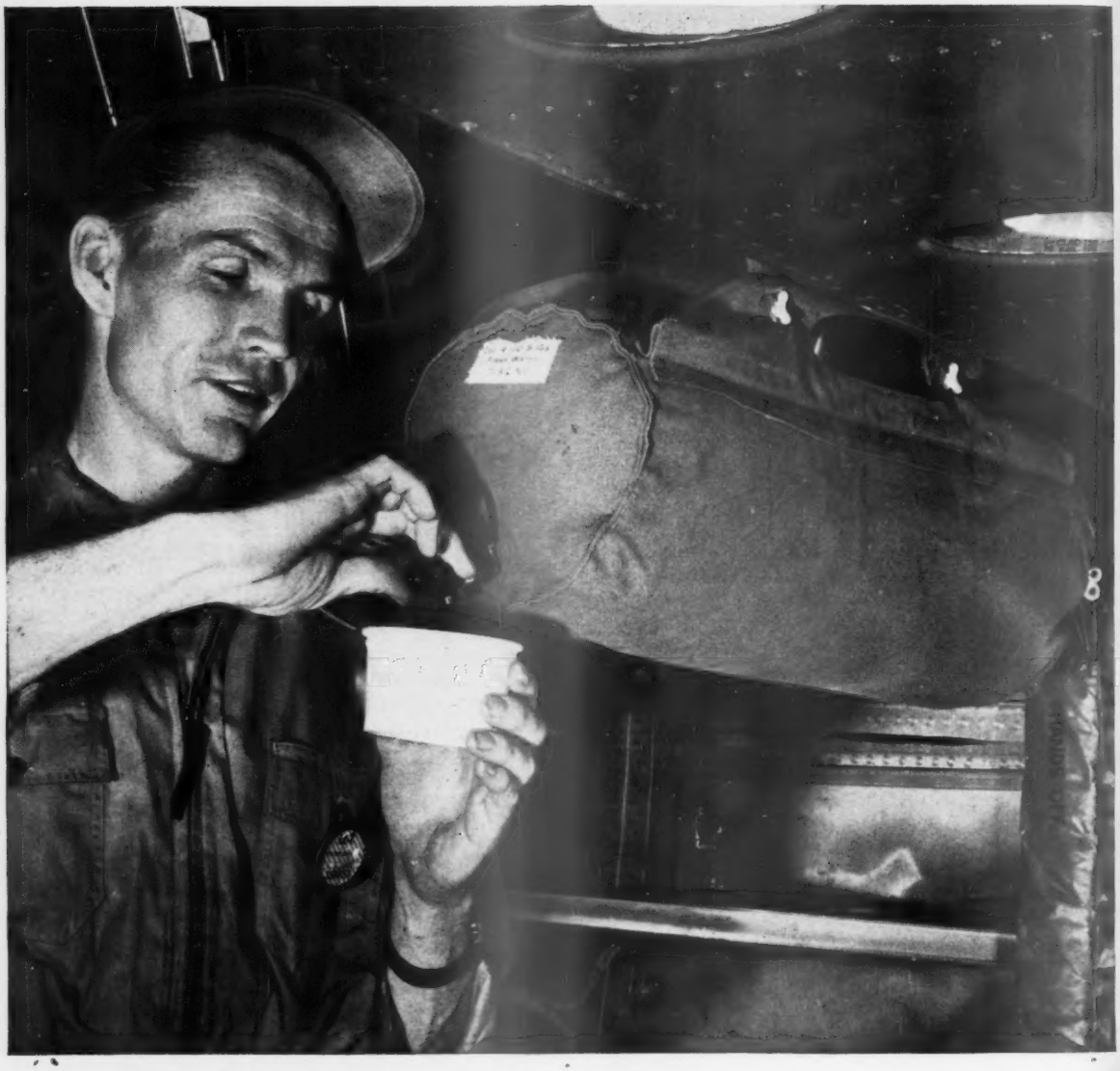

This bag helps water travel light

For maximum bomb and fuel capacity, designers of Convair's 139-ton B-36 wanted to trim every possible pound off its gross weight. One problem was to find a new material for the drinking water tanks—lighter than the metal used for standard tanks, yet strong enough to carry the load.

B. F. Goodrich engineers tackled the job. They found that light, tough Koroseal flexible material made an ideal water bag—carrying all the water needed for the 14-man crew at only one-seventh the weight of a metal tank!

There were still other advantages in using Koroseal flexible material. It doesn't affect the taste of the water as many tank linings do. It does not corrode. It is permanently waterproof. And it is tough enough to withstand severe sloshing effects. Koroseal water bags are now standard equipment on the B-36.

Carrying drinking water is only one of the many aviation jobs which Koroseal flexible material does so well. Its special properties have been put to good use in aileron seals, garbage bags, seat back bladders, and as flame-resistant coating for materials used to line baggage compartments and pilot's cabins.

Koroseal flexible material was developed by B. F. Goodrich engineers. Their constant research has steadily improved it. And they are continually finding new, important applications. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

B.F.Goodrich
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Aerodynamics

Transonic and Supersonic Research. Charles A. Nicholson. *The Pegasus*, Vol. 11, No. 1, January 1, 1948, pp. 12–16, illus.

CONTROL SURFACES

Wind-Tunnel Investigation of the Effects of Slot Shape and Flap Location in the Characteristics of a Low-Drag Airfoil Equipped with a 0.25-Chord Slotted Flap. Ralph W. Holtzclaw and Yale Weisman. *U.S., N.A.C.A., Memorandum Report No. A4L28 (Wartime Report No. A-80)*, December, 1944. 51 pp., illus. 2 references.

Aerodynamic Characteristics and Flap Loads of the Brake-Flap Installation on the 0.40-Scale Model of the F4F-3 Left Wing Panel. Paul E. Purser and Robert B. Liddell. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-549)*, October, 1942. 52 pp., illus. 12 references.

Wind-Tunnel Investigation of a Revised Horizontal Tail Surface for the Grumman TBF-1 Airplane. John W. McKee and Robert B. Liddell. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-702)*, February, 1943. 41 pp., illus. 10 references.

Tests of a 0.30-Scale Semispan Model of the Douglas XTB2D-1 Airplane Wing and Fuselage Combination in the NACA 19-Foot Pressure Tunnel. I—Full-Span Flap and Air-Brake Investigation. C. Dixon Ashworth, Stanley H. Spooner, and Robert T. Russell. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-563)*, September, 1944. 95 pp., illus. 4 references.

Flight Tests of a Rudder With a Spring Tab on an F6F-3 Airplane (BuAer No. 04776). Walter C. Williams. *U.S., N.A.C.A., Memorandum Report No. L5C19 (Wartime Report No. L-718)*, March 1945. 25 pages, illus. 3 references.

Wind-Tunnel Investigation of a Low-Drag Airfoil Section With a Double Slotted Flap. Seymour M. Bogdonoff. *U.S., N.A.C.A., Advance Confidential Report No. 3120 (Wartime Report No. L-697)*, September, 1943. 12 pp., diagrs. 3 references.

Wind-Tunnel Investigation of an NACA 23012 Airfoil With an 18.05-Percent-Chord Maxwell Slat and With Trailing-Edge Flaps. Clarence L. Gillis and John W. McKee. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-574)*, October, 1941. 17 pp., diagrs. 7 references.

Flight Tests of Dive-Recovery Flaps on an XP-51 Airplane. De E. Beeler and Walter C. Williams. *U.S., N.A.C.A., Advance Confidential Report L5D20a (Wartime Report No. L-778)*, May, 1945. 35 pp., illus. 1 reference.

Flight Investigation of Modifications to Improve the Elevator Control-Force Characteristics of the Curtiss SB2C-1C Airplane in Maneuvers. Maurice D. White and John P. Reeder. *U.S., N.A.C.A., Memorandum Report No. L5D04a (Wartime Report No. L-719)*, April, 1945. 25 pp., illus. 1 reference.

Flight Tests of Modifications to Improve the Aileron Control Characteristics of a North American XP-51 Airplane (A. C. No. 41-38). M. D. White and Herbert H. Hoover. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-636)*, June, 1942. 13 pp., illus. 3 references.

Flight Measurements of the Effect of Various Amounts of Aileron Droop on the Low-Speed Lateral-Control Characteristics of an Observation Airplane. William N. Turner and Betty Adams. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. A-79)*, August, 1943. 120 pp., illus. 2 references.

Wind-Tunnel Investigation of the Effects of Profile Modification and Tabs on the Characteristics of Ailerons on a Low-Drag Airfoil (NACA 66, 2-216 (a = 0.6)). Robert M. Crane and Ralph W. Holtzclaw. *U.S., N.A.C.A., Report No. 803*, 1944. 50 pp., diagrs. 5 references. U.S. Govt. Printing Office, Washington. $0.30.

Wing Spoiler Proves Its Worth in Searching Development Tests. Robert McLarren. *Aviation Week*, Vol. 48, No. 6, February 9, 1948, pp. 30, 32. 15 references. A review.

FLUID MECHANICS & AERODYNAMIC THEORY

On Source and Vortex Distribution in the Linearised Theory of Steady Supersonic Flow. A. Robinson. *College of Aeronautics, Cranfield, England, Report No. 9*, October, 1947. 28 pp., figs. 8 references.

In evaluating the flow across a surface surrounding a supersonic source, the resultant hyperbolic integral becomes infinite. This

difficulty can be overcome by introducing the concept of the finite part of an infinite integral which was first defined by Hadamard. By the application of this concept, formulas are delivered for the field of flow due to an arbitrary distribution of supersonic sources and vortices. This field under steady supersonic conditions can be calculated in strict analogy with the method of Stokes and Helmholtz in classical hydrodynamics. The results are in agreement with Schlichting's for the particular case of a horseshoe vortex.

The Linearized Theory of Supersonic Flow. H. J. Stewart. *California Institute of Technology, Jet Propulsion Laboratory, Report No. 4-26* (*Power Plant Laboratory Project MX527*), February 22, 1946. 18 pp., fig. 9 references.

When the fundamental linearized theory of supersonic flows is applied to the simplest conical flow problem, the flow past a cone at zero angle of attack, it is found that the theory cannot be used satisfactorily to predict the variation with Mach Number of the pressure increment on the face of the cone. This appears to be a characteristic difficulty for all axially symmetric flows about projectile-like bodies. This result is in distinct contradiction to that found in the two-dimensional supersonic thin airfoil theory.

On Similarity Rules for Transonic Flows. Carl Kaplan. *U.S., N.A.C.A., Technical Note No. 1527*, January, 1948. 16 pp., tables. 6 references.

A method used by Tsien to derive similarity rules for hypersonic flows is utilized to derive von Kármán's similarity rules for transonic flows. At the lower limit of the transonic region of flow, the theory yields a formula for the critical stream Mach Numbers of a given family of symmetrical profiles. It is further shown that this formula can also be obtained by means of the Prandtl-Glauert small-perturbation theory.

Charts for the Analysis of One-Dimensional Steady Compressible Flow. L. Richard Turner, Albert N. Addie, and Richard H. Zimmerman. *U.S., N.A.C.A, Technical Note No. 1419*, January, 1948. 61 pp., figs.

Charts to facilitate the solution of flow processes involving variable and constant specific heats, friction, heat transfer, and combustion with a change in mass flow and the accompanying change in momentum. The static-pressure and total-pressure parameters used in the charts are made dimensionless by multiplying the parameter computed from the given data by a factor that is given in Table I. In order to facilitate plotting special curves where greater accuracy is desired, the computed data used in the plots are tabulated in Tables II and III. Table IV gives values of the nondimensional parameters at the critical pressure ratio for four values of the ratio of specific heats. The flow charts plot the velocity parameter, the total-pressure parameter, and the total-momentum parameter against the static-pressure parameter. The static-pressure parameter covers a range from 0 to 4.4 for a fluid with a constant ratio of specific heats of 1.40 (cold air). The static-pressure parameter for hot gases with variable specific heats covers a range from 0 to 2.2. Three values of the instantaneous ratios of the specific heats at the total temperature of the fluid, 1.26, 1.30, and 1.34, were chosen for the calculations, and linear vertical interpolation may be used for intermediate values. The use of the charts is illustrated by sample computations of the flow in a convergent-divergent nozzle and in an under-expanding jet and by calculation of the total temperature of a fluid from its measured jet thrust.

A Numerical-Graphical Method of Characteristics for Axially Symmetric Isentropic Flow. Lester L. Cronvich. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 155–162, figs. 11 references. (Cf. AER 1/48:28.)

On Axially Symmetric Flows. Alexander Weinstein. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 429–444. 10 references.

An extension of the method of sources and sinks in which their distribution is not confined to the axis of the body but in which they are distributed on circumferences, rings, discs, and cylinders. The flows from these sources are superimposed on a uniform flow in the direction of the axis of symmetry of the body. Beltrami's fundamental results are corrected, and these formulas, many of which contain Stokes' stream function as a many valued function, are used to obtain essentially new types of flows, the flows around blunt-nosed profiles.

A New Derivation of the Method of Characteristics for Axially Symmetrical Supersonic Flow. Andrew Vazsonyi. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 499–503, figs. 4 references.

A simple derivation of the differential equation that expresses the change in the magnitude and direction of the velocity vector along a Mach wave. The equation can be specialized to obtain two-dimensional and irrotational flows.

Letter to the Editor. A. Kahane. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 179, 180, diagrs.

A rule analogous to that which applies to the calculation of the intersection of characteristics in two-dimensional steady isentropic flow can be stated for one-dimensional unsteady isentropic flow as follows: The change of velocity and speed of sound across the incident leg of a characteristic is equal to the change of velocity and speed of sound, respectively, across the refracted leg.

Can Man Fly? Brian Worley. *Aeronautics*, Vol. 18, No. 3, February, 1948, pp. 22–26, diagrs.

Investigation has shown that man is capable of an initial output of approximately 1.4 hp. of muscular energy for a few seconds. He can deliver a sustained output of about 0.55 hp. These ratings represent about 60 per cent of the power required to fly the most efficient man-power-driven aircraft designed to date. Specifications and power requirements are given for the pedal-powered Haessler-Villinger and the Bossi-Bonomi "Pedialante" and the Windspiel sailplane.

On Drone Flies, Gyroscopes and Balancers. *Interavia*, Vol. 2, No. 12, December, 1947, pp. 24, 25, illus. A brief account of research conducted by the Sperry Gyroscope Company.

INTERNAL FLOW

A Note on Compressible Flow in a Tube of Slightly Varying Cross-Section. G. N. Ward. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2183*, December, 1945. 7 pp., diagrs. 1 reference. British Information Services, New York. $0.55.

If the supersonic flow in a tube (e.g., in the test section of a supersonic wind tunnel) is not uniform initially, the nonuniformity persists and oscillates about the mean flow. In a circular tube the disturbance tends to concentrate on the axis and at the wall. For subsonic flow in a straight tube no oscillatory disturbances occur, and any initial nonuniformity is damped out downstream.

Preliminary Investigation of Supersonic Diffusers. Arthur Kantrowitz and Coleman duP. Donaldson. *U.S., N.A.C.A., Advance Confidential Report No. L5D20* (*Wartime Report No. L-713*), May, 1945. 22 pp., diagrs. 3 references.

An investigation of the deceleration of air in channels from supersonic to subsonic velocities. Stable flow was found to involve a normal shock in the diverging part of the diffuser. The losses occasioned by this shock can be minimized by making the throat area as small as possible for a given entrance Mach Number. The maximum contraction ratio calculated to permit starting of supersonic flow at a given entrance Mach Number corresponded closely with experimental results. Diffusers designed according to these calculations, starting without initial boundary layer, recovered over 90 per cent of the kinetic energy in supersonic air streams up to a Mach Number of 1.85.

Airflow Around the Blades of Blower Stators. von Vietinghoff-Scheel. (*Braunschweig, Luftfahrtforschungsanstalt Hermann Göring, ZWB/UM/2142*, November, 1944.) *U.S., Air Force, Translation No. F-TS-3261-RE*, February, 1948. 7 pp., illus.

Flow tests, by means of schlieren photographs, were made on blades of two blower stators. Pitch ratio of both stators was the same with various angles of attack. First blade examined was 1.5 mm. thick and placed on reinforced wire with spacers to hold it in place. Second blade was thicker and installed in conventional manner. Blade 1 showed a separation on concave side of profile at leading edge at large angle of flow. When angle of flow increased to 62°, tests of blade II showed a weak separation of flow at front of profile.

An Investigation of the Ranger V-770-8 Engine Installation for the Edo XOSE-1 Airplane. II—Aerodynamics. Mark R. Nichols and John S. Dennard. *U.S., N.A.C.A., Memorandum Report No. L5I12b* (*Wartime Report No. L-562*), October, 1945. 102 pp., illus. 7 references.

An Experimental Investigation of Flow Conditions in the Vicinity of an NACA D_o-Type Cowling. Robert W. Bonswikle and Rosemary P. Bryant. *U.S., N.A.C.A., Memorandum Report No. L6H14* (*Wartime Report No. L-747*), August, 1946. 46 pp., illus. 1 reference.

Note on the Simple Ram-Air Intake Preceded by Normal Shock in Supersonic Flight. John D. Stanitz. *Journal of the Aero-*

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nautical Sciences, Vol. 15, No. 3, March, 1948, pp. 181–183, diagrs. 3 references. (Cf. AER 12/47:28.)

Internal and External Aerodynamics of Ducted Bodies at Supersonic Speeds. Clinton E. Brown. *U.S., N.A.C.A., Confidential Bulletin No. L6B26 (Wartime Report No. L-728)*, April, 1946. 26 pp., figs. 12 references.

PARASITIC COMPONENTS & INTERFERENCE

Drag Measurements on Some Windscreen-Fuselage Combinations in the High Speed Tunnel. J. A. Beavan, G. A. M. Hyde, and S. J. Moore. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2235*, July, 1940. 2 pp., diagrs. British Information Services, New York. $0.25.

Flight Investigation of Factors Affecting the Carburetor Ram and Nacelle Drag of an A-26B Airplane. J. Ford Johnston, Bernard B. Klawans, and Edward C. B. Danforth, III. *U.S., N.A.C.A., Memorandum Report No. L6F21 (Wartime Report No. L-740)*, July, 1946. 42 pp., illus. 6 references.

An Investigation of the Mutual Interference of a Tail-Surface—Stern Propeller Installation on a Model Simulating the Douglas XB-42 Empennage. Walter A. Bartlett, Jr., and Alfred A. Marino. *U.S., N.A.C.A., Memorandum Report No. L4K09 (Wartime Report No. L-625)*, November, 1944. 85 pp., illus. 2 references.

PERFORMANCE

Operational Aerodynamics of High-Speed Transport Aircraft. Richard S. Shevell. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 133–143, diagrs. 2 references. (Cf. AER 9/47:31.)

Generalized Selection Charts for Bombers Powered by One, Two, Four, and Six 2000-Horsepower Engines. M. J. Brevoort, G. W. Stickle, and Paul R. Hill. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-655)*, July 1942. 41 pp., figs. 1 reference.

Analysis of V-G Records From the SNB-1 Airplane. Walter G. Walker and May T. Meadows. *U.S., N.A.C.A., Memorandum Report No. L6F27a (Wartime Report No. L-759)*, July, 1946. 18 pp., figs. 3 references.

STABILITY & CONTROL

A Dynamic Longitudinal Stability Analysis for a Canard Type Airplane in Supersonic Flight. Charles W. Cole and Bernard B. Levitt. *California Institute of Technology, Jet Propulsion Laboratory, Memorandum No. 4-21*, June 15, 1947. 45 pp., figs. 10 references.

Compressibility effects exercise a great influence on the dynamic stability quartic coefficient for supersonic speeds in that range of Mach Numbers where the variation of rate of change of the lift coefficient to the angle of attack is relatively large. The delta wing with the Mach wave ahead of the leading edge and the rectangular wing are unstable for a canard type of aircraft under the assumptions made in this analysis. The configuration was found to be stable with delta wings when a fin of the same plan form was used.

The Effect of Mass Distribution on the Lateral Stability and Control Characteristics of an Airplane as Determined by Tests of a Model on the Free-Flight Tunnel. John P. Campbell and Charles L. Seacord, Jr. *U.S., N.A.C.A., Report No. 769*, 1943. 13 pp., illus. 8 references. U.S. Govt. Printing Office, Washington. $0.15.

Tests of a $^1/_7$-Scale Powered Model of the Kaiser Tailless Airplane in the Langley Full-Scale Tunnel. G. W. Brewer and E. A. Rickey. *U.S., N.A.C.A., Memorandum Report No. L6C13 (Wartime Report No. L-531)*, March, 1946. 91 pp., illus. 5 references.

Aerodynamic Characteristics of a $^1/_5$-Scale Powered Model of a High-Speed Bomber With a Dual Pusher Propeller Aft of the Empennage. James S. Weiberg and Alfred W. Schnurbusch. *U.S., N.A.C.A., Memorandum Report No. A5J12 (Wartime Report No. A-89)*, October, 1945. 78 pp., illus. 8 references.

Power-On Longitudinal-Stability and Control Tests of the $^1/_8$-Scale Model of the Brester F2A Airplane Equipped With Full-Span Slotted Flaps and a New Horizontal Tail. John G. Lowry and Thomas A. Toll. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-709)*, March, 1942. 39 pp., illus. 4 references.

Aerodynamic Characteristics of a 4-Engine Monoplane Showing Effects of Enclosing the Engines in the Wing and Comparisons of Tractor- and Pusher-Propeller Arrangements. Abe Silverstein and Herbert A. Wilson, Jr. *U.S., N.A.C.A., Advance Confidential Report (Wartime Report No. L-456)*, April, 1938. 43 pp., illus. 2 references.

Measurements of the Flying Qualities of a Bell P-39D-1 Airplane (A.A.F. No. 41-28378). Harold I. Johnson, C. J. Liddell, and H. H. Hoover. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-602)*, September, 1943. 84 pp., illus. 2 references.

Résumé of NACA Stability and Control Tests of the Bell P-63 Series Airplane. Harold I. Johnson. *U.S., N.A.C.A., Memorandum Report No. L4J19 (Wartime Report No. L-601)*, October, 1944. 82 pp., illus.

Flying Qualities and Stalling Characteristics of North American XP-51 Airplane (A.A.F. No. 41-38). Maurice D. White, Herbert H. Hoover, and Howard W. Garris. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-566)*, April, 1943. 94 pp., illus. 3 references.

Measurement of Flying Qualities of a Douglas A-26B Airplane (AAF No. 41-39120). III—Stalling Characteristics. S. A. Sjoberg, H. L. Crane, and H. H. Hoover. *U.S., N.A.C.A., Memorandum Report No. L5A04a (Wartime Report No. L-607)*, January, 1945. 25 pp., illus. 3 references.

Flight Measurements of the Flying Qualities of an F6F-3 Airplane (BuAer No. 04776). III—Stalling Characteristics. Walter C. Williams and John P. Reeder. *U.S., N.A.C.A., Memorandum Report No. L5B13b (Wartime Report No. L-717)*, February, 1945. 21 pp., illus. 2 references.

Flight Investigation to Improve the Dynamic Longitudinal Stability and Control-Feel Characteristics of the P-63A-1 Airplane (AAF No. 42-68889) with Closely Balanced Experimental Elevators. Harold I. Johnson. *U.S., N.A.C.A., Memorandum Report No. L6E20 (Wartime Report No. L-730)*, July, 1946. 66 pp., illus. 5 references.

Longitudinal-Trim Tests of a 0.059-Scale Model of the Curtiss-Wright XP-55 Airplane. George F. MacDougall, Jr., and Leslie E. Schneiter. *U.S., N.A.C.A., Memorandum Report No. L5G31 (Wartime Report No. L-538)*, August, 1945. 38 pp., illus. 3 references.

WINGS & AIRFOILS

The Flow at the Rear of a Two-Dimensional Supersonic Airfoil. A. Kahane and Lester Lees. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 167–170, diagrs. 3 references.

Aerodynamics of Thin Quadrilateral Wings at Supersonic Speeds. Robert M. Snow. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 417–428, figs. 2 references.

Busemann's method of conic fields is used to study the linearized supersonic flow about some special cases of the plane wing at small angles of attack. The characteristic cones and the boundary conditions of a finite plane wing and the case of intersecting envelopes are used to study the lift coefficient and center of pressure of a symmetrical trapezoidal wing. The development is further extended to the general symmetrical quadrilateral and the case of a wing with dihedral combined with forward or backward sweep at the dihedral point.

Notes on Laminar Flow and Laminar-Flow Airfoils. Richard G. Naugle. *Aero Digest*, Vol. 56, No. 2, February 1948, pp. 40, 41, 113, 114, illus.

The shifting of the point of transition of the boundary-layer flow from laminar to turbulent, which was investigated in the development of unconventional wing profiles over which the pressure distribution and velocity distribution were controlled. These profiles find application at high speeds where local velocities may become critical.

Tests on a Tapered Wing (NACA 23012) With and Without Sweepback in the Compressed Air Tunnel. D. H. Williams, A. F. Brown, and C. J. W. Miles. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2151*, May, 1945. 39 pp., figs.

Wind-Tunnel Tests on a 30 per Cent Suction Wing. E. J. Richards, W. S. Walker, and C. R. Taylor. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2149*, July, 1945. 22 pp., diagrs. 9 references. British Information Services, New York. $1.30.

Tests of a Griffith Aerofoil in the 13 ft. x 9 ft. Wind Tunnel. I—Wind Tunnel Technique and Interim Note. E. J. Richards. **II—Effect of Concavity on Drag.** E. J. Richards, W. S. Walker,

and J. R. Greening. **III—The Effects of Wide Slots and of Premature Transition to Turbulence.** E. J. Richards and W. S. Walker. **IV—Lift, Drag, Pitching Moments and Velocity Distributions.** E. J. Richards and W. S. Walker. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2148,* March, 1944. 49 pp., diagrs. 13 references. British Information Services, New York. $2.65.

Tests were made on a 16 per cent thick Griffith suction airfoil to verify the feasibility of the Griffith "discontinuity" principle. Quantitative data were obtained on the airfoil characteristics both with and without suction, on the amount of suction needed to prevent separation, and on the optimum slot shape and width that gave maximum efficiency. **I.** The experimental technique is outlined. The results are interpreted so as to include in the drag a term to account for the power used to develop the necessary suction. **II.** The transition of the boundary layer which was observed to occur some distance to the rear of the slot resulted from the dynamic instability of the layer along a concave surface. It is impossible to design any practical airfoil shape over which this instability can be prevented at the Reynolds Numbers of flight. **III.** Slot design and the effect on suction mass flow of premature transition to turbulence forward is investigated. **IV.** The velocity distribution over the airfoil, the lift coefficient, the pitching moments, and hinge moment variation with incidence are determined both with and without suction. The effective drag coefficient variation is extrapolated to full-scale Reynolds Numbers.

Drag Measurements at High Reynolds Numbers of a 100-Inch-Chord NACA 23016 Practical Construction Wing Section Submitted by Chance Vought Aircraft Company. Albert E. von Doenhoff and Robert J. Nuber. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-752),* June, 1944. 12 pp., illus. 2 references.

Tests of NACA 65(216)-420 and 66(218)-420 Airfoils at High Speeds. Joseph L. Anderson. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. A-87),* April, 1944. 65 pp., illus. 8 references.

The Effects of a Highly Cambered Low-Drag Wing and of Auxiliary Flaps on the High-Speed Aerodynamic Characteristics of a Twin-Engine Pursuit Airplane Model. Victor M. Ganzer. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. A-90),* February, 1944. 57 pp., illus. 2 references.

Aeronautics—General Aspects

'47 Roundup Shows Progress Despite Difficulties in Many Phases of U.S. Civil, Military Aviation. *National Aeronautics,* Vol. 27, No. 1, January, 1948, pp. 4–10, illus.

Aeronautics in 1947. I, II. *The Engineer,* Vol. 185, Nos. 4797, 4798, January 2, 9, 1948, pp. 21–23; 48, 49, illus.

I. British development in civil and research aircraft and rotating wing aircraft. **II.** Military and naval aircraft, guided and rocket missiles, and research and development equipment.

Quarterly Bulletin, Aeronautical Laboratories, National Research Council of Canada. *Report No. ME 1947 (3),* July 1–September 30, 1947. 26 pp., illus., diagrs.

Contents: Model Testing Basins; Current Projects in Aerodynamics Laboratory, Aircraft and Allied Instruments Laboratory, Engine Laboratory, Flight Research Section, Gas Dynamics Section, Gasoline and Oil Laboratory, Hydraulics Laboratory, Low Temperature Laboratory, and Structures Laboratory; Note on Aeronautical Library; Note on Technical Translations.

Air Power

The Navy's Stake in the Future. Guy Richards. *U.S. Naval Institute, Proceedings,* Vol. 74, No. 540, February, 1948, pp. 175–196, illus.

The minimum requirements for national defense, naval countermeasures against guided missiles and invasion by sea, and the operation of the Navy in a counteroffensive or a situational war call for the extension of the Navy's functions to include the operation of radar and guided missiles and both sea- and land-based aircraft.

The Navy Provides the First Line of Defense on, Under and Above the Sea. Chester W. Nimitz. *U.S. Air Services,* Vol. 33, No. 1, January, 1948, pp. 17–20, illus.

Airpower Based on Obsolete Types; Aircraft Industries Association Study Shows 90 Percent of Service Planes Out of Production. *Aviation Week,* Vol. 48, No. 2, January 12, 1948, p. 14.

Airplane Design & Descriptions

Design of Fighter Aircraft. H. R. Foottit. *Aero Digest,* Vol. 56, No. 2, February, 1948, pp. 23, 24, 108–110, 113, illus. A schematic classification of military aircraft by operational and tactical employment. Basic design and performance requirements are specified for each type.

An Epitome of Aircraft Entry Patterns. *Aeronautics,* Vol. 18, No. 2, January, 1948, pp. 43–45, diagrs. 7 references.

The cruciform empennage violates the principle of economy of means. The elevator and rudder surfaces contribute unnecessary form and surface drag to the air frame and only duplicate functions that can be performed equally well by sweptback wings with ailerons and elevons.

Development of All-Wing Aircraft. J. K. Northrop. *Shell Aviation News* (London), No. 114, December, 1947, pp. 12–19, illus.

What's Wrong With Our Airliners? II. *Canadian Aviation,* Vol. 21, No. 2, February, 1948, pp. 38, 40, 56, 62, illus.

Civil Airworthiness Requirements. Walter Tye. *The Aeroplane,* Vol. 73, No. 1907, December 26, 1947, pp. 823, 824, illus.

A survey of the development of the I.C.A.O. Airworthiness Requirements. The structural strength, power-plant and flight-performance standards are compared with current British and American specifications.

Foundations for '48; Technical Advances Achieved During the Old Year. *Flight,* Vol. 53, No. 2036, January 1, 1948, pp. 3–8, illus.

Spring Tabs. II, III. F. B. Baker. *Aircraft Engineering,* Vol. 19, Nos. 225, 226, November, December, 1947, pp. 347–352; 380–384, 389; illus., figs. (Cf. AER 3/48:57.) Calculations of rudder and elevator response, stick force, follow-up ratio, preloading, and trimming.

Is the Existing Control Column Out-Of-Date? *Plane Facts,* Vol. 4, No. 6, December, 1947, pp. 18, 22, diagrs.

Description of a "three-dimensional" control system. A control arm on each side of the pilot is so linked that rudder pedals are eliminated and all control movements are performed with the arms. This system can be used with the pilot in either the conventional or the prone position.

The Emergency Lowering of Undercarriages. Maurice F. Allward. *Aeronautics,* Vol. 18, No. 3, February, 1948, pp. 34, 35, diagr.

The basic design of emergency systems using an alternative fluid, compressed air, or a slow-burning cartridge for the operation of hydraulic undercarriage systems and electric landing-gear retraction systems.

Some Recent Developments in the Landing Gear Field. René Lucien. *Royal Aeronautical Society, Journal,* Vol. 52, No. 448, January, 1948, pp. 27–61, Discussion, pp. 62–74, illus. (Cf. AER 3/48:57.)

Stratocruiser Landing Gear System. *Boeing Service Guide,* No. 4, January, 1948, pp. 2–4, cutaway drawing.

The Goodyear Single Disc Brake. H. N. Harben. *The Technical Instructor,* Vol. 3, No. 1, January, 1948, pp. 3–9, diagrs.

Plastic Ducts to Assist Designers. *Aviation Week,* Vol. 48, No. 2, January 12, 1948, pp. 26, 27, illus.

Chronicles of Jet Propulsion. I, II. *The Aeroplane Spotter,* Vol. 9, Nos. 204, 205, January 10, 24, 1948, pp. 10, 22, illus. I. Design and manufacture of jet-propelled airplanes in Argentina, Canada, China, and Czechoslovakia. **II.** France.

Newer English Jet-Type Fighters Delayed Until 1950. *Aviation Week,* Vol. 48, No. 7, February 16, 1948, pp. 22, 23. Includes cutaway drawing of the de Havilland Sea Vampire MR. XX.

Czecho Choice. William Green and K. B. Hopfinger. *Aeronautics,* Vol. 18, No. 2, January, 1948, pp. 24–29, illus. Descriptions of current Czechoslovakian aircraft.

Flying To-Day—Russia. *The Aeroplane Spotter,* Vol. 9, No. 205, January 24, 1948, p. 16, diagrs. Three-view drawings of the Yak jet Fighter, Yak-11 trainer, LA rocket-assisted fighter, and LA-7 trainer.

New Shapes in the Air: The Avro 689 Tudor VII, The Boeing 367 YC-97A Stratofreighter, The Ilyushin IL-18, The Tupolev

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TU-70. *The Aeroplane Spotter*, Vol. 9, No. 204, January 10, 1948, pp. 4, 5, illus.

Transports Today and Tomorrow. I—Large Landplanes. H. F. King. *Flight*, Vol. 52, No. 2035, December 25, 1947, pp. 717–723, illus.

New Shapes in the Air: The Handley Page H.P. 74 Hermes II and the Lockheed Model XR60-1 Constitution. *The Aeroplane Spotter*, Vol. 9, No. 205, January 24, 1948, p. 17, illus.

American Medium Bombers: Douglas Invader and North American Mitchell. *The Aeroplane*, Vol. 73, No. 1906, December 19, 1947, p. 782, illus.

Two-Place Flying Wing (Aerobat Aircraft Company, Model B). *Southern Flight*, Vol. 29, No. 1, January, 1948, pp. 12, 13, illus.

Airspeed (Ambassador) Liner New Export Rival. Albert E. Smyser, Jr. *Aviation Week*, Vol. 48, No. 4, January 26, 1948, pp. 21, 22, illus.

Aeroplanes in Detail. LXXVII—The Armstrong-Whitworth A.W. 52. *The Aeroplane Spotter*, Vol. 9, No. 205, January 24, 1948, p. 18, cutaway drawing.

Tailless Research With Twin Jets (Armstrong Whitworth A.W. 52). *The Aeroplane*, Vol. 74, No. 1910, January 16, 1948, pp. 73–77, illus., cutaway drawing.

The A.W. 52 Shows Its Paces in Public. *The Aeroplane*, Vol. 73, No. 1907, December 26, 1947, pp. 808, 809, illus.

Airborne Wing; Inspection of the A.W. 52 in Flight and on the Ground: First Public Appearance. *Flight*, Vol. 52, No. 2035, December 25, 1947, pp. 724, 725, illus.

On the Wing; A.W. 52 Tests Commence: Control Systems. *Flight*, Vol. 53, No. 2038, January 15, 1948, pp. 69–73, illus., cutaway drawings.

Athena Mk. II Trainer with Merlin 35(Avro). *The Aeroplane*, Vol. 74, No. 1912, January 30, 1948, pp. 132–134, illus., cutaway drawing.

On the Air Routes. I—Avro York. *The Aeroplane Spotter*, Vol. 9, No. 204, January 10, 1948, p. 9, illus.

The Boeing Stratocruiser Transport—I. A. Marthason. *The Aeroplane*, Vol. 74, No. 1912, January 30, 1948, pp. 128, 129, 130, 131, illus.

The New Type 170: Complete Performance and Operating Data in Graph Form. *The Bristol Aeroplane Co., Ltd.*, 1947. 23 pp.

Flight in the Canadair Four (DC-4M). Ronald A. Keith. *Canadian Aviation*, Vol. 21, No. 2, February, 1948, pp. 17, 18, 32, 58, illus.

Versatile "Canadair Four" Candidate for World Airways (DC-4M). Ronald A. Keith. *Canadian Aviation*, Vol. 21, No. 2, February, 1948, pp. 14–16, illus. Development of the aircraft from the DC-4M and the TCA "North Star" M-2. Performance of the Canadair Four and the M-2 compared.

The De Havilland "Chipmunk." William Green. *Interavia*, Vol. 2, No. 12, December, 1947, pp. 40–42, illus.

Flying the (de Havilland) Vampire (III). R. G. Worcester. *The Aeroplane*, Vol. 73, No. 1903, November 28, 1947, pp. 702–705, illus.

An Amphibious Feeder-Liner (Grumman Mallard). *The Aeroplane*, Vol. 73, No. 1903, November 28, 1947, pp. 706, 707, illus.

The Grumman Panther (XF-9F2) With Rolls-Royce Nene. *The Aeroplane*, Vol. 73, No. 1907, December 26, 1947, p. 822, illus.

Four Variations of Military 2-0-2. *The Martin Star*, Vol. 6, No. 12, January, 1948, p. 5, diagrs.

M-B V in the Air; Reflections Upon Flying the Martin-Baker Fighter: Rolls-Royce Griffon Engine With "Contraprop." M. A. Smith. *Flight*, Vol. 52, No. 2034, December 18, 1947, pp. 679–681, illus.

Flying the M.B. 5 Fighter (Martin-Baker). R. G. Worcester. *The Aeroplane*, Vol. 74, No. 1909, January 9, 1948, pp. 48–51, illus.

The New Basic Trainer; Structural Analysis of the Percival Prentice. *Flight*, Vol. 52, No. 2034, December 18, 1947, pp. 689–695, illus., cutaway drawings.

The R.A.F.'s New Trainer (Percival Prentice T. Mk I). *The Aeroplane*, Vol. 73, No. 1906, December 19, 1947, pp. 788, 791, illus., cutaway drawings.

The Short Sealand (Transport). *The Aeroplane Spotter*, Vol. 9, No. 204, January 10, 1948, p. 8, cutaway drawing.

The Short Q1/46 (Naval Target-Towing Aircraft). *The Aeroplane*, Vol. 73, No. 1903, November, 1947, pp. 695, 696, illus.

Spiteful and Seafang: The Supermarine Spiteful and The Supermarine Seafang. *The Aeroplane*, Vol. 73, No. 1907, December 26, 1947, p. 814, illus.

Ground Attack and Fleet Cover: The Supermarine Spitfire and The Supermarine Seafire. *The Aeroplane*, Vol. 73, No. 1903, November, 1947, pp. 700, illus.

Airports & Airways

What Is an Aerodrome? *Aeronautics*, Vol. 18, No. 3, February, 1948, p. 75, tables.

Definitions of terms which are recommended for adoption by the Aerodromes, Air Routes and Ground Aids Division of I.C.A.O.; and tables showing the classification of land and water aerodromes.

Air Traffic Control. D. Barnett. *The Aeroplane*, Vol. 73, No. 1907, December 26, 1947, pp. 816–819, illus.

An analysis of the basic requirements of an ideal airport traffic-control plan. The system developed by the R.A.F. Transport Command at present can operate at the rate of 20 to 30 aircraft per hour in conditions of poor visibility. The equipment, approach procedure, and computations required by the system are outlined in detail.

Airline Trials of Distance Measuring Equipment and of the Multiple Track Radar Range; Operational Aspects of Tests Made Over the Sydney-Melbourne Air Route January–May, 1947. *Australia, Department of Civil Aviation*, October, 1947, 18 pp., diagrs.

Reliability, accuracy, and range of the installations met specifications. In operation the systems were judged practical. One disadvantage of the Multiple Track Radar Range was found to be the lack of omnidirectional characteristics, particularly in the approach control zone.

Skyway 1 and Other Proposed Skyways. *Airports*, Vol. 13, No. 1, January, 1948, pp. 23–25, 27–30, 32–38, 40–46, 48, 50, diagrs.

Metropolitan Control Zone; Plans for Control of Air Traffic Into London Airports. *Flight*, Vol. 52, No. 2034, December 18, 1947, pp. 684, 685, diagrs.

The New British Air Traffic Control System. *The Aeroplane*, Vol. 74, No. 1909, January 9, 1948, pp. 52–54, maps. Outline of the United Kingdom traffic-control plan that became effective for the London area on January 15, 1948.

Rational Airport Planning; The Unidirectional Runway. E. Payson Hall. *Airports and Air Transportation*, Vol. 2 (New Series), No. 56, January, 1948, pp. 254–256, illus.

High Intensity Visual Aids. I. *The Log*, Vol. 8, No. 1, January, 1948, pp. 10–15, illus. A brief account of some recent developments at the R.A.E.

Landing Through Overcast. Wilbur T. Harding. *Electrical Engineering*, Vol. 66, No. 12, December, 1947, pp. 1176, 1177, illus.

Tests were conducted at Arcata, Calif., to determine the feasibility of commercial aircraft landings under adverse weather conditions. The proper installation of ILS and GCA systems, wide-angle distribution runway illumination, and thermal visual landing aids made landings under visibility conditions as low as 660 ft. practicable.

They're Taking the Fear Out of Fog. Wesley Price. *The Saturday Evening Post*, Vol. 220, No. 34, February 21, 1948, pp. 20, 21, 87, 90, 92, illus. The work of the Landing Aids Experiment Station at Arcata, Calif.

All-Weather Flying

Bad Weather Is Their Business (U.S. Air Forces All-Weather Flying Division). Carlyle H. Jones. *Sperryscope*, Vol. 11, No. 4, December, 1947, pp. 8–12, illus.

ICE PREVENTION

Thermal Fin Effect in Heat Anti-Icing Corrugations. Julius Jonas. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 163–166, diagrs. (Cf. AER 8/47:31.)

Temperature Distribution on the Heated Edge of Ju 88 Fighter and Bomber Wings (Engine-Exhaust Hot-Air System). Wen-

The problems of turbulent air currents caused by external radio antennas have been overcome in this Air Force C-54 by special modifications developed by Goodyear Aircraft Corporation. Although this plane is equipped with ten radio sets, a special resin-impregnated material, which replaces aluminum surfaces at indicated points, prevents the shielding of radio waves from antennas within these sections of the airplane.

then. (*Göttingen, Aerodynamische Versuchsanstalt, ZWB/-AVAG/AP7/42*, September, 1942.) *U.S., Air Force, Translation No. F-TS-2654-RE*, February, 1948. 22 pp., illus.

Boeing Stratocruiser Thermal Anti-Icing. *Shell Aviation News* (London), No. 114, December, 1947, p. 22, illus.

Icing in Jets. *Canadian Aviation*, Vol. 21, No. 1, January, 1948, pp. 20–23, 44, 54, illus. (Cf. AER 3/48:61.)

Summary of results obtained by the National Research Council of Canada in a series of tests conducted during the winter of 1947 to determine the physical factors governing ice formation in jet units.

Atomic Energy

The Nucleus—Its Structure and Reactions. W. E. Shoupp and Hugh Odishaw. *Electrical Engineering*, Vol. 67, No. 2, February, 1948, pp. 125–134, diagrs. 3 references.

Aviation Medicine

The Relative Effectiveness of Presenting Numerical Data by the Use of Scales and Graphs. *U.S., Air Forces, Air Materiel Command, Engineering Division, Aero Medical Laboratory, Memorandum Report No. TSEAA-694-1M*, December 22, 1947. 17 pp., figs.

New Guns for Human Bullets. George H. Waltz. *Popular Science*, Vol. 152, No. 2, February, 1948, pp. 99–102, illus.

The Special Devices Center of the Office of Naval Research is constructing at Johnsville, Pa., a centrifuge capable of producing an acceleration of 40g. Three designs for jettisonable cockpits are described.

Action Potentials During Tracking. Douglas G. Ellson and Harris Hill. *U.S., Air Force, Air Materiel Command, Engineering Division, Aero Medical Laboratory, Memorandum Report No. TSEAA-694-21*, December 31, 1947. 18 pp. 1 reference. Includes: Action Potentials During Tracking. Douglas G. Ellson and Harris Hill. Indiana, University, Department of Psychology, Report No. 9, October, 1947. Analysis of the muscular action used in the operation of sighting instruments.

Comfortization

Pressurisation and Cabin Air Control. W. M. Widgery. *Royal Aeronautical Society, Journal*, Vol. 51, No. 444, December, 1947, pp. 949–967, Discussion, pp. 967–980, illus.

Military operations made it necessary to provide oxygen supply for crews of fighter aircraft. The pressurized cabins that were developed made it necessary to select pressures at which the systems would operate, the rate of change of pressure with variations in altitude, and methods of temperature control. The development of high-altitude commercial aircraft extended the problem to one of complete air conditioning of the cabin and introduced more complex problems of heating, humidification, drying, refrigeration, and distribution and circulation of the air in the cabin. The Westland Welkin is used as an example of the basic pressurization layout and the Avro Tudor I illustrates a typical cabin air-control system for the commercial aircraft. Alternate methods and techniques are compared. The Tudor I system represents a saving of nearly 500 lbs. over the full oxygen equipment that would otherwise have to be carried.

Oxygen for Passengers; Details of New Developments for Oxygen Supply in Civil Aircraft. *Flight*, Vol. 53, No. 2036, January 1, 1948, pp. 15, 16, illus.

Noise Reduction Devices Shown on Modified Stinson Voyager. Alexander McSurely. *Aviation Week*, Vol. 48, No. 2, January 12, 1948, p. 29, illus.

Test of Cabin Heating System in Me 262 Turbojet Fighter. R. Joachim. (*Messerschmitt AG, Augsburg, Me/ VB/262-06A-45*, February, 1945.) *U.S., Air Force, Translation No. F-TS-2812-RE*, January, 1948. 1 pp.

Electronics

Partial Report on the Test of the Patin Automatic Direction-Finding Installation. Scherer. (*Deutsche Lufthansa A.G., Staaken, Mx/DLH/B/247/7*, June, 1942.) *U.S., Air Force, Translation No. F-TS-1901-RE*, January, 1948. 10 pp.

Report of preliminary flight tests of an automatic pilot that operates directly from the 1.5-millivolt output of the direction-finder receiver. The installation, based entirely on relay control, operates with no amplification of the direction-finder output voltage.

Radar Navigation. A. Levin. *Electronics Forum*, No. 7, September, 1947, pp. 19–33, illus. Operation and characteristics of the centimetric P.P.I. navigation system, the range-measuring beacon, and the hyperbolic radar navigation system.

New Aid to Air Navigation; The Gee Mark III System (Cossor Radar) for Medium-Size Airliners. *Airports & Air Transportation*, Vol. 2 (New Series), No. 56, January, 1948, pp. 262, 263, illus.

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Radar's Magic Eye to Remap Australia. John Loughlin, *Indian Aviation*, Vol. 31, No. 11, November, 1947, pp. 258–260.

Ultrasonic Delay Lines. I. H. B. Huntington, A. G. Emslie, and V. W. Hughes. *Franklin Institute, Journal*, Vol. 245, No. 1, January, 1948, pp. 1–24, diagrs.

An analysis of the theory of ultrasonic delay lines containing piezoelectric transducers operating in thickness vibration. An equivalent circuit is developed in which a transmission line is employed as an element. Expressions are derived for the radiation pattern of a crystal transmitting single-frequency compressional vibrations into a semi-infinite medium, the radiation pattern in a semi-infinite tube with a vibrating crystal at one end, and the attenuation of a free-space beam and a guided beam.

Recording of Oscillograph Traces. *Electronics Forum*, No. 7, September, 1947, pp. 32–34, illus.

Description of a special-purpose camera developed by Avimo Ltd. A bank of $1^1/_2$-in. cathode-ray tubes record on a moving 70-mm. film. Fifteen traces and a timing trace can be accommodated side by side on the record.

Flight Record Aids Safety, Efficiency. Clare L. Beattie and Philip J. Klass. *Aviation Week*, Vol. 48, No. 2, January 12, 1948, pp. 21, 23, 24, illus.

Description of the General Electric remote type of flight recorder. A miniature low torque selsyn transmitter attached directly to standard aircraft instruments transmits their indication to a selsyn follow-up located in the tail of the airplane. The follow-up controls a stylus that scores the white lacquer coating of black pressure-sensitive recording paper.

Design Principles of Amplitude-Modulated Subcarrier Telemeter Systems. Cecil K. Stedman. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 1, January, 1948, pp. 36–41, diagrs. 1 reference.

An analysis of the problems of cross talk from adjacent channels, filter design, and signal-to-noise ratio. A multichannel overload criterion is set up which is simply related to single-signal overload, and it is easy to use. Nothing is gained by spacing filter midband frequencies in such a way that harmonics of lower subcarriers fall outside the pass band of higher-frequency channel filters. The signal-to-noise ratio can be improved by spacing the subcarrier frequencies much more closely than would otherwise be possible.

Method of Identifying Metal Bodies by Means of Centimeter Waves. Otto Macek. (*Oberpfaffenhofen, Flugfunk-Forschungsinstitut, ZWB/UM/4008*, March, 1944.) *U.S., Air Force, Translation No. F-TS-1821-RE*, January, 1948. 15 pp., illus.

Centimeter waves are transmitted from low-flying aircraft. The intensity of the reflection of these signals is measured in the aircraft. Iron plates, 5 by 9 m., could be identified at an altitude of 70 m.

Printed Circuit Techniques. Cledo Brunetti and Roger W. Curtis. *U.S., National Bureau of Standards, Circular No. 468*, November 15, 1948. 43 pp., illus. 60 references. U.S. Govt. Printing Office, Washington. $0.25.

A comprehensive treatment of the field of printed circuits giving production details and the limitations of the various methods of printing: painting, spraying, chemical deposition, vacuum process, die stamping, and dusting. The principal advantages of printed circuits are uniformity of production and reduction of size, assembly and inspection time and cost, line rejects, and purchasing and stocking problems. Illustrations and circuit diagrams of production models are included.

Printed Circuit Techniques. Cledo Brunetti and Roger W. Curtis. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 1, January, 1948, pp. 121–161, illus. 60 references.

Impulse-Modulation Oscillator C 299. Walther Hahne. (*Drahtlostelegraphischeund Luftelektrische Versuchsstation, Graefelfing, EIS/Graf/292*, October, 1942.) *U.S., Air Force, Translation No. F-TS-2020-RE*, January, 1948. 13 pp., illus.

Some General Results in the Theory of Noise Through Non-Linear Devices. David Middleton. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 445–498, diagrs. 28 references.

Electromagnetic Radiation Through an Insulating Medium With Imbedded Metal Filaments. Fritz Sauter. (*München, Technische Hochschule, ZWB/THM*, December, 1944.) *U.S., Air Force, Translation No. F-TS-1118-RE*, February, 1948. 17 pp.

The Absolute Calibration of Vibration Pickups. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 32, No. 1, January, 1948, pp. 8–10, figs. (Cf. AER 4/48:71.)

An Electric Field Meter for Use on Airplanes. R. C. Waddel. *Review of Scientific Instruments*, Vol. 19, No. 1, January, 1948, pp. 31–35, illus. 11 references.

An instrument for measuring the magnitude and polarity of electric fields on the surface of an airplane in flight. The meter covers a range of 5 to 4,000 volts per cm. and is powered by a 28-volt d.c. supply.

Polar Recorder Has Optical Centering Device. *Product Engineering*, Vol. 19, No. 2, February, 1948, pp. 108, 109, illus.

The type 116 Polar Recorder developed by Airborne Instruments Laboratory, Inc., was designed to plot aircraft antenna radiation patterns. The recorder will chart voltage as an ink trace 0.025-in. wide on either a linear or a logarithmic scale as radial distance against angular position.

Klystrons. Wilhelm Reusse. (*Tellow-Seehof-Berlin, Mx/RPF/574*, January, 1942.) *U.S., Air Force, Translation No. F-TS-2726-RE*, January, 1948. 4 pp.

Relations Between the Transmitting and Receiving Properties of Antennas. A. F. Stevenson. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 369–384, diagrs. 8 references.

The Cylindrical Antenna With Gap. Ronold King and T. W. Winternitz. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 403–416, diagrs. 12 references.

Concerning a New Transcendent, Its Tabulation and Application in Antenna Theory. C. J. Bouwkamp. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 394–402, tables. 4 references.

Engineering Practices & Aids

British, American and Metric. Curtis L. Bates. *Aeronautics*, Vol. 18, No. 2, January, 1948, pp. 30, 31, tables.

An analysis of the difficulties inherent in the British and American systems of measurement.

Equipment

ELECTRICAL

Aircraft Electrical Systems. R. H. Woodall. *The Aeroplane*, Vol. 74, No. 1909, January 9, 1948, pp. 45–47, colored cutaway drawings. A summary of the development of aircraft electric supply systems.

Cranking Motor Service. William A. Crouse. *Aviation Service Magazine*, January, 1948, pp. 14, 15, 18, 40, illus.

Inspection, maintenance, and trouble-shooting instructions for the Delco-Remy aircraft cranking motor. The data is applicable to motors using the Bendix drive or an over-running clutch drive.

HYDRAULIC & PNEUMATIC

Two-Pressure Aircraft Hydraulic System. T. C. Hill and E. G. Riley. *Machine Design*, Vol. 20, No. 2, February, 1948, pp. 123–128, illus.

In order to obtain the economy of weight provided by a 3,000 lb. per sq.in. hydraulic system and yet not lose the advantages of reliability and security from external leakage of lower-pressure systems, a compromise installation was adopted for the Martin 2-0-2. A 3,000-lb. open-center circuit that controlled the landing gear and the wing flaps contained an unloading valve to bleed off fluid for an independent closed-center 1,500-lb. system for the operation of brakes, windshield wipers, and the nose-wheel steering gear.

Hydraulic Shock Absorber Orifice Designs and Equations. Joseph Brown. *Product Engineering*, Vol. 19, No. 2, February, 1948, pp. 92–95, illus.

Equations are derived for the design of orifices for hydraulic shock absorbers, buffers, and dashpots. Methods are discussed for obtaining values for transient pressures and velocities for five basic types of orifices.

Liquid Springing and Its Application to Aircraft Landing Gear. P. B. Locke. *The Technical Instructor*, Vol. 2, No. 12, December, 1947, pp. 1–10, illus.

Aircraft Pneumatics; Some Current Applications. *Flight*, Vol. 53, No. 2038, January 15, 1948, pp. 74–76, diagrs.

The design and application of pneumatic circuits for the operation of aircraft auxiliary power-supply units. Bleeding air from the compressor of gas-turbine units permits efficient operation of pneumatic installations at high altitudes. The use of pressures in the vicinity of 1,000 lbs. per sq.in. accomplishes substantial savings in weight of the equipment.

Evaluation of Aircraft Pneumatics Indicates Commercial Applications. Scholer Bangs. *Aviation Week*, Vol. 48, No. 3, January 19, 1948, pp. 26, 27.

Pneumatic controls for aircraft promise reduction of weight and cost, elimination of fire hazards, insensitivity to temperature changes, and split-second operation.

Fuels & Lubricants

Some Possibilities for Rocket Propellants. III. Arthur S. Leonard. *American Rocket Society, Journal*, No. 72, December, 1947, pp. 10–23, tables. 6 references.

Data on liquid rocket propellants includes: tabulation of representative types of compounds, graphs of calculated jet velocities and bulk densities for over 300 combinations, and the periodic table with a figure-of-merit assigned to the elements to indicate its performance as a rocket fuel. Oxygen and fluorine appear to be the best oxidants. The best oxidizer appears to be fluorine monoxide, followed by fluorine, nitrogen trifluoride, ozone, and oxygen. The best fuels appear to be hydrogen, lithium, beryllium, and boron. The propellant combinations of reasonably high density which might be expected to produce the highest jet velocities are fluorine monoxide used with a mixture of beryllium and hydrazine or with boron hydrides.

Rocket Researchers Sift Fuels to Reduce High Consumption. Robert McLarren. *Aviation Week*, Vol. 48, No. 4, January 26, 1948, p. 18. 1 reference.

Thermochemistry of Rocket Propellants. George P. Sutton. *American Rocket Society, Journal*, No. 72, December, 1947, pp. 2–9, diagrs.

Fuels and Lubricants for Jet Engines. Edward A. Smith. *Aeronautics*, Vol. 18, No. 2, January, 1948, pp. 32–35, diagrs.

Analysis of the characteristics required of fuels and lubricants for jet engines. To date kerosene has been found to be the most satisfactory fuel. No completely satisfactory lubricant has been found because of the demands of low-temperature starting and the high operating temperatures of the turbine.

The Petroleum Industry and Jet Propulsion. W. E. Kuhn. *Aero Digest*, Vol. 56, No. 2, February, 1948, pp. 70–76, illus.

A discussion of the fuel and combustion problems presented by the turbojet, the duct type, the ram-jet, and the solid-fuel and the liquid-fuel power plants. For each type of combustor the Texas Company, at its Fuels and Lubricants Laboratory, is attempting to develop fuels with improved flame stability, greater heat content per unit volume, lower freezing points, and cleaner burning.

Japanese Fuels and Lubricants; Naval Research on Alcohol Fuel. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./922*, February, 1946. 180 pp., illus. British Information Services, New York. $4.00.

The shortage of aviation fuels in Japan stimulated the investigation of the production and employment of alcohols as aviation fuels. Ten reports by Japanese investigators detail the research conducted on ethanol, methanol, and butanol fermentation, saccharification of starch-bearing roots and grains, and hydrolysis of wood, the absorption of inorganic nutrients in the alcoholic fermentation of yeast, the synthesis of methanol, production of higher alcohols from cracked petroleum gases, the production of ether and acetone from ethyl alcohol, and the synthesis of butanol from water gas. Seven reports treat of the employment of alcohols as fuels, the spectroscopic investigation of the mechanism of alcohol combustion and the effect of knock inhibitors, the corrosive properties of alcohol, the prevention of corrosion of magnesium and magnesium alloys, and alcohol-proof paints.

A Rapid Compression Machine Suitable for Studying Short Ignition Delays. W. A. Leary, E. S. Taylor, C. F. Taylor, and J. U. Jovellanos. *U.S., N.A.C.A., Technical Note No. 1332*, February, 1948. 65 pp., illus. 21 references.

A machine developed to study the ignition delay of fuels by means of a rapid adiabatic compression. Essential features of the machine are: (1) compression is completed in about 0.006 second; (2) simultaneous records can be obtained for piston motion and cylinder pressure; and (3) the combustion cylinder is unlubricated. The apparatus opens new possibilities for studying the detonation characteristics of fuels. The tests can be conducted on a few millimeters of fuel.

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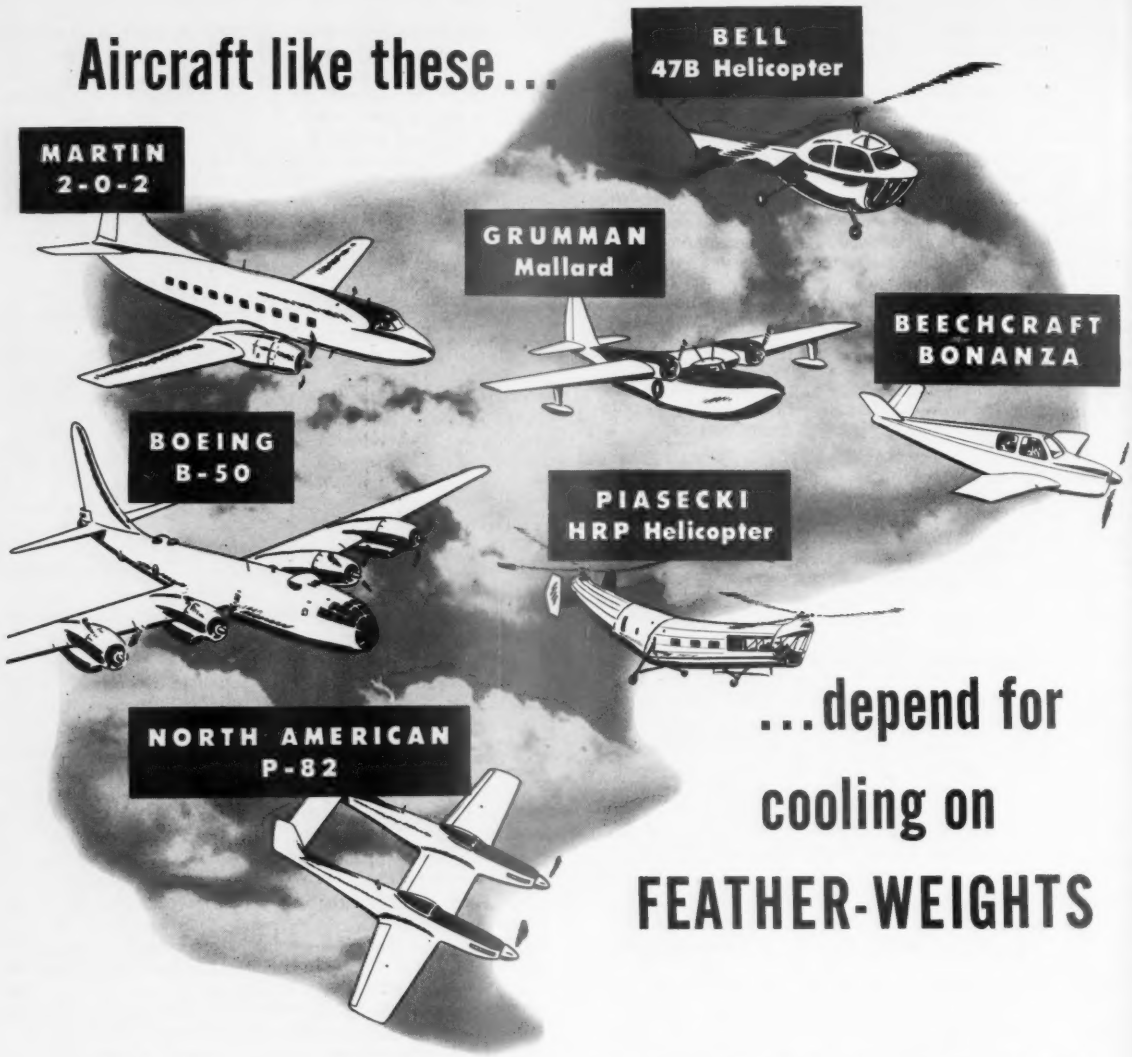

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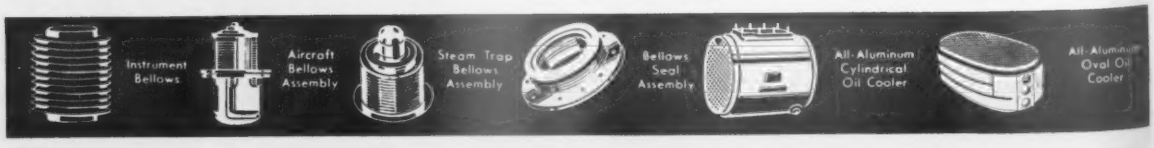

Oiliness and Boundary Phase Friction. H. Umstätter. (*Die Technik*, Vol. 2, No. 4, April, 1947, pp. 171–176.) *Engineers' Digest*, Vol. 4, No. 12, December, 1947, pp. 570–572, figs.

Lubrication Factors in Bearing Design. *Machinery*, Vol. 54, No. 5, January, 1948, pp. 146–153, illus.

Gliders and Gliding

Centre of Gravity-Launch. Heinz Funk. *Sailplane and Glider*, Vol. 16, No. 1, January, 1948, pp. 2, 3, diagrs.

If the direction of pull of the tow cable passes through the center of pressure of the glider in the climbing attitude, the drag produced by a deflected elevator can be eliminated and greater heights attained with the same length of cable.

Free-Spinning, Longitudinal-Trim, and Tumbling Tests of 1/17.8-Scale Models of the Cornelius XFG-1 Glider. Ralph W. Stone, Jr., and Lee T. Daughteridge, Jr. *U.S., N.A.C.A., Memorandum Report No. L5K21 (Wartime Report No. L-738)*, January, 1946. 50 pp., illus. 2 references.

General Aircraft Research Gliders; Principal Features of "Medium V," "Medium U" and "Maximum V" Designs. *Flight*, Vol. 53, No. 2036, January 1, 1948, p. 14, illus.

Slingsby Sailplanes (Kirby Cadet and Tutor, and Slingsby 21B and Gull IV). *Flight*, Vol. 53, No. 2037, January 8, 1948, p. 38, illus.

Guided Missiles

Comparisons of Flight Paths of Missiles Guided by Different Methods. Wilhelm Magnus. (*Amstgruppe Mar Ruest-FEP, ZWB/(M-F)FB/10*, April, 1944.) *U.S., Air Force, Translation No. F-TS-4026-RE*, January, 1948. 11 pp. 1 reference.

A mathematical analysis of two generalizations of three-point-alignment pursuit curves. Control systems operating on a torpedo-rocket pursuit curve take into account the solid angle between a beam from the target to the reference point and from the target to the projectile. Bomb-rocket pursuit curves maintain the distance between the reference point and the target and the distance between the reference point and the projectile equal under all conditions.

Paths of Target-Seeking Missiles in Two Dimensions. Charles E. Watkins. *U.S., N.A.C.A., Advance Confidential Report No. L6B06 (Wartime Report No. L-735)*, July, 1946. 63 pp., figs.

Differential equations of highly simplified two-dimensional pursuit paths are developed for the path of a missile controlled by a target seeker, when the target seeker is installed to provide normal pursuit navigation, constant navigation, proportional navigation, and line-of-sight navigation. The curves obtained from the analytical solutions of the equations for normal pursuit and constant navigation show that pursuit paths with finite curvature are obtained only if the ratio of the velocity of the missile to that of the target is less than 2. Curves obtained from differential-analyzer solutions of the equations for proportional navigation show that the pursuit paths improve as the rate of navigation and/or the ratio of the velocity of the missile to that of the target is increased. Proportional navigation is thus concluded to be the best method of using a target seeker installed in a missile.

Guided Missiles. C. E. Chapel. *Radio News*, Vol. 39, No. 1, January, 1948, pp. 39–41, illus.

Guided missiles are classified by their launching site and target, the method of propulsion, and the type of control used. Control technique developed from preaiming the trajectory to remote piloting in which line-of-sight target approach and transmission of flight progress by television, echoes, or guide beams were used. Experiments with these methods culminated in the completely automatic target-seeking missile, the Bat, which fixes itself on its target by the echoes of the radar impulses it transmits. Photographs and brief descriptions of 16 guided missiles are included.

Telemetry for Guided Missiles. L. J. Neelands and Walter Hausz. *Radio News*, Vol. 39, No. 1, January, 1948, pp. 3–6, 20, illus.

Specifications and detailed description of the G.E. Telemetry system. Missile-borne equipment weighs 23 lbs., occupies 0.2 cu.ft., and can transmit 28 channels or multiples thereof. Fixed and mobile receiving stations record data on a continuously moving 35-mm. film. Three types of presentation are provided: horizontal lines proportional in length to the duration of the transmitted pulse, one for each channel, grouped in frames of 28; a display of dashes with all channels in series in a single line, supplying a compact qualitative representation for initial examination; and a display of dots for use when time variations of the quantities are of primary interest. Block diagrams and wave forms at various points in the unit are given.

Summary of Results Obtained in Research on Missiles. Alvin Walther. (*Darmstadt, ZWB/TH Darm/18/9*, January, 1940.) *U.S., Air Force, Translation No. F-TS-327-RE*, January, 1948. 9 pp.

Brief summaries of reports made on research projects set up in the fall and winter of 1939; oscillation, stability, performance, trajectory, and control calculations for guided missiles; development of a differential equation machine from the Adler-Ott integraph; atmospheric density at high altitudes; and estimation of the status of research.

Directional Control of the Feuerlilie Ground-to-Air Missile. (*Allgemeine Elektricitäts-Gesellschaft, ZWB/LFA/59/44*, November, 1944.) *U.S., Air Force, Translation No. F-TS-2895-RE*, January, 1948. 10 pp.

Determination of the guide beam control constants and the operation of the model control circuit. Actuation of the hydraulic control linkage is accomplished by mechanical linkage to a rotating magnet excited by an alternating current. Command signals superimposed on this current change the ratio of the control periods and produce corresponding rotation of the magnet. Test results agreed with theoretical calculations.

Rocket's Flight Kept in Sight. Martin Mann. *Popular Science Monthly*, Vol. 152, No. 1, January, 1948, pp. 128–132, illus.

Description of the direct observation moving-picture photographic telescope and the Dovap equipment that employs the Doppler effect to obtain a photographic record of the behavior of rocket missiles in flight.

Air Force Exploration of the Upper Atmosphere. *Plane Facts*, Vol. 4, No. 6, December, 1947, pp. 11, 12, 21, 22. Description of the instruments that will be used and the data they will obtain during flights of the V-2 rocket into the upper atmosphere.

Guided Missiles Need a Navy. Daniel V. Gallery. *The Pegasus*, Vol. 11, No. 1, January 1, 1948, pp. 10, 11, illus.

Checking the "Test Birds." *Aero Digest*, Vol. 56, No. 2, February, 1948, pp. 49, 103, illus.

North American Aviation's plan to use the SCR-584 radar tracking system for observation of the pilotless missiles that will be launched in connection with its aerophysics research problem.

History & Literature

Highest—Fastest—Farthest; A Summary and Examination of Existing World's Air Records. *Flight*, Vol. 53, No. 2040, January 29, 1948, pp. 111–114.

Anti-Aircraft Command, 1939–45. *The Aeroplane Spotter*, Vol. 9, No. 204, January 10, 1948, pp. 6, 7, illus.

Japan's Homeland Aerial Defense. Bertram Vogel. *U.S. Naval Institute, Proceedings*, Vol. 74, No. 540, February, 1948, pp. 175–181.

Hydrodynamics

Seaplanes Can Be Good Airplanes. Charles J. Daniels. *Aero Digest*, Vol. 56, No. 2, February, 1948, pp. 38–39, illus.

The conflict between hydrodynamic and aerodynamic characteristics presents itself in the designing of seaplane hulls that possess good flight characteristics. The conventional hull may be constructed in segments. When the seaplane translates from air to water operation, the articulating segments could shift their relative position and deform the streamline of the hull to irregular configuration with good hydrodynamic characteristics.

Take-Off Performance of Light Twin-Float Seaplanes. John B. Parkinson. *U.S., N.A.C.A., Technical Note No. 1524*, February, 1948. 28 pp., diagrs. 9 references.

Light twin-float seaplanes are apt to have poor take-off performance because of high water resistance at speeds near take-off. The development of float forms with large afterbody clearance and low resistance at planing speeds such as the N.A.C.A. planing-tail hull offers promise of improved take-off performance.

Resistance Tests of a $^1/_{16}$-Size Model of the Hughes-Kaiser Flying Boat, NACA Model 183. Roland E. Olson, Jack Posner,

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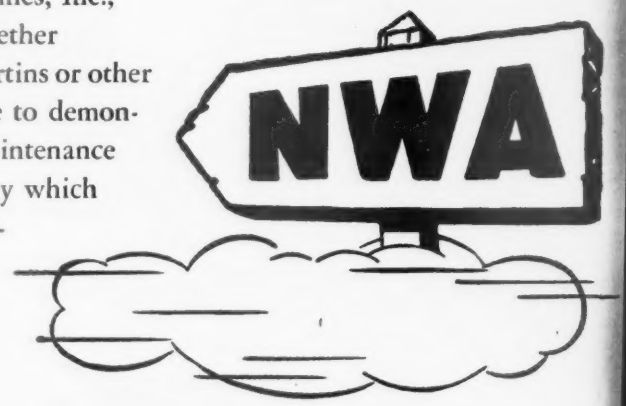

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and David R. Woodward. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-683)*, June, 1944. 42 pp., illus. 5 references.

Sr/45; Preliminary Survey of the Big Saunders-Roe Flying Boat Now Being Constructed at Cowes. *Flight*, Vol. 53, No. 2038, January 15, 1948, pp. 63–68, illus., cutaway drawings.

Big British Flying-Boats; Progress of the SR/45; Simultaneous Construction of the Three. *Modern Transport*, Vol. 58, No. 1504, January 24, 1948, p. 9, illus.

The Aerodynamic Tests of Three Edo Floats for the SB2U-3, OS2U-2, and XSB2C-2 Seaplanes—NACA Models 106-K, 107-K, and 125-AH. Robert B. Liddell. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-722)*, March, 1942. 14 pp., illus. 2 references.

Preliminary Tests to Determine the Dynamic Stability Characteristics of Various Hydrofoil Systems for Seaplanes and Surface Boats. James M. Benson and Douglas A. King. *U.S., N.A.C.A., Restricted Bulletin No. 3K02 (Wartime Report No. L-756)*, November, 1943. 14 pp., figs. 5 references.

An Investigation of Hydrofoils in the NACA Tank. I—Effect of Dihedral and Depth of Submersion. James M. Benson and Norman S. Land. *U.S., N.A.C.A., Advance Confidential Report (Wartime Report No. L-758)*, September, 1942. 34 pp., diagrs. 3 references.

Ditching Tests with a $^1/_{11}$-Size Model of the Army B-25 Airplane in NACA Tank No. 2 and on an Outdoor Catapult. George A. Jarvis and Margaret F. Steiner. *U.S., N.A.C.A., Memorandum Report No. L4J11 (Wartime Report No. L-623)*, October, 1944. 29 pp. 1 reference.

Instruments

High-Range True Air-Speed Indicator. R. D. Munnikhuysen. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 5, March 1, 1948, pp. 7–12, diagrs.

A direct reading true-air-speed indicator designed to operate over a range of speeds from subsonic to above 1.75 Mach and at altitudes over 150,000 ft. The indication is obtained by reference to the distance between a spark gap and an ion detector. The negative atmospheric ions formed by the breakdown of the spark are carried by the air stream past the ion detector which is excited by electrostatic induction. A master oscillator controls both the spark timing and the sweep of the synchroscope speed indicator. The angular deviation between the pip on the scope indicating the spark breakdown and the pip indicating the detection of the ions supplies a direct measure of the velocity of the air moving from the gap to the detector.

Method for Measuring Air Temperature on a High-Speed Airplane. K. Terada and G. Yamamoto. *Journal of Meteorology*, Vol. 4, No. 6, December, 1947, pp. 201, 202, diagrs. 5 references.

The difference between the indication of thermometers and the true air temperature which is caused by the speed of the aircraft has been found to be proportional to the square of the speed of the air stream outside the boundary layer. Since change in velocity, pressure, and temperature takes place when air flows through a constriction, it was reasoned that a venturi tube could be designed to compensate for this difference in indication. Flight tests of a thermometer so designed showed the theory to be correct. Upon increasing the flight speed from 250 to 400 km. per hr., an error of only 0.7 °C. was observed in the indication.

An Electric Flow Meter. J. H. Laub. *Electrical Engineering*, Vol. 66, No. 12, December, 1947, pp. 1216–1219, illus. 4 references.

An electrocaloric flow meter can indicate rates of flow of aviation gasoline from 0 to 2,000 lbs. per hr. Two resistance thermometers, one upstream and one downstream from an electric heat input, form two of the legs of a Wheatstone bridge circuit. The bridge is balanced to a given temperature differential and the fluctuation of its null detector is used to control the current input to the heater. A wattmeter in the heater circuit gives a reading that bears a linear relationship to the rate of flow. A watt-hour meter calibrated in pounds totalizes the flow. A third resistance thermometer in series with one of the fixed-resistance legs of the bridge shifts the balance of the bridge to compensate for variation in the characteristics of the fluid with changes in temperature, thus reducing the temperature error to 0.5 per cent within a temperature range of 0° to 50 °C.

A Substitute for Time (Sperry Engine Analyzer). F. A. Breen. *Sperryscope*, Vol. 11, No. 4, December, 1947, pp. 20–24, illus.

Application of Locus-Curve Theory to Control Problems. Ludwig. *(Peenemünde, Heeresanstalt, ZWB/PA/86/107*, August, 1942.) *U.S., Air Force, Translation No. F-TS-2141-RE*, January, 1948. 4 pp., figs.

An investigation of the relationship that exists between the number of revolutions of the regulator curve about the zero point of its complex plane and the stability of the oscillation system.

Application of the Desyn System. C. Williams. *The Technical Instructor*, Vol. 3, No. 1, January, 1948, pp. 11–14, diagrs.

In addition to being used as a fuel-contents gage and a position indicator, a microtransmitter has been developed which enables the Desyn system to be used for indicating pressures.

Automatic Flight; Air Force Report of C-54D Test. *Instruments*, Vol. 21, No. 1, January, 1948, pp. 6, 8, 10, 12.

Analytical Investigation of the Stability of an F8F Dropping Model With Automatic Stabilization. Doris Cohen. *U.S., N.A.C.A., Memorandum Report No. L5L03 (Wartime Report No. L-780)*, December, 1945. 34 pp., diagrs. 1 reference.

Kollsman Power Recorders. *Square D Company, Kollsman Instrument Division*, January, 1948. 6 pp., diagrs.

The Kollsman Power Recorders type 1175 and type 1028B measure the engine r.p.m. by either a direct flexible shaft connection with the engine tachometer outlet or an electrical connection with an electric tachometer generator. This measurement is integrated with the manifold pressure and the atmospheric pressure in such a manner that the actual power units required during any given period of operation are counted by the machine. The instrument is calibrated in accordance with the power curves of the engine to indicate at the rate of 100 units per hour when the engine is operated at normal cruising power and proportionally more or less units if the engine is operated above or below this norm.

The Story of the Altitude Indicator. Elliott S. Hertzmark. *Air Trails Pictorial*, Vol. 30, No. 4, January, 1948, pp. 38, 39, 106–110, illus. Historical.

You and Your Altimeter. Robert W. Prescott, Jr. *Flying*, Vol. 42, No. 1, January, 1948, pp. 48, 49, illus. The reading and interpretation of altimeter indications.

Stall-Warning Indicators Refined (Manufactured by Gordonay Products Co. and Safe Flight Instrument Corp.). Albert E. Smyser, Jr. *Aviation Week*, Vol. 48, No. 6, February 9, 1948, pp. 21, 23, 24, illus.

Lighter-Than-Air

Exploring the Sky by Proxy. Otto C. Winzen. *Progress Thru Research*, Vol. 2, No. 2, Winter, 1948, pp. 5, 6, illus.

The General Mills Aeronautical Research Laboratories are launching research balloons to a height of 100,000 ft., carrying 70 lbs. of scientific instruments. The balloons are made of an extremely thin plastic and measure 70 ft. in diameter and 100 ft. in length.

Machine Elements

The Production of Favorable Internal Stresses in Helical Compression Springs by Pre-Stressing. D. G. Sopwith. *(Preprint, Institute of Metals, Symposium on Internal Stresses in Metals and Alloys*, October, 1947.) *Engineers' Digest*, Vol. 4, No. 12, December, 1947, pp. 558–560, figs.

Ball and Roller Bearings. Bryce T. Ruley. *Product Engineering*, Vol. 19, No. 2, February, 1948, pp. 123–126, illus. The importance of misalignment, friction, deflation, lubrication, and operating speed in the choice of each of the ten basic types of roller contact bearings.

Dynamic Forces in Cam Mechanisms. John A. Hrones. *Machine Design*, Vol. 20, No. 1, January, 1948, pp. 135–138, diagrs.

Ball Bearing Slides. Conrad Jobst. *Machine Design*, Vol. 20, No. 1, January, 1948, pp. 138–140, diagrs.

Maintenance

Maintenance Difficulties in the Field. M. J. Kemper. *Royal Aeronautical Society, Journal*, Vol. 51, No. 444, December, 1947, pp. 981–991.

A discussion of the maintenance problems of military aircraft which arose because of the lack of interchangeability of components, parts, and accessories, the profusion of nonstandard lines, connections, fittings, instruments, and tools, the unavailability of spare parts, the design of ground handling equipment, and the inadequate packing and protection of replacements during shipment. Reduction of maintenance difficulties will decrease maintenance time and increase the total flying time of an aircraft. To this end basic aircraft design should take into account actual operating conditions, accessibility of assemblies and subassemblies, interchangeability of parts and standardization of accessories and equipment.

Douglas Service, Vol. 6, No. 2, February, 1948. 20 pp., illus.

Contents: DC-6 Doors, Inspection and Proper Adjustment. Toilet Leakage, DC-6. Landing Gear Servicing, DC-4, DC-6, Tools Used in Build-up, Installation, and Servicing. Instrument Range Markings, DC-6, Limits for All Operational Instruments. Wing Heaviness, DC-4, Causes and Corrections. Service Interphone, DC-6, Description of System. Revised Cabin Supercharger Oil System, DC-6, New Schematic of Low-Speed Drive. Hydraulic Assemblies, Protection of Units During Storage. Fuel Quantity Power Units, DC-6. Brake Lock-out Cylinders, DC-6, Description and Function. Engine Mount Torque Chart, DC-6. Rockwell Hardness Testing, Proper Procedure and New Hardness Rating Tables. Static Antenna Insulation, DC-6, Two New Methods. Throttle Control Rigging Fixture, DC-6, Use During Adjustment Procedure.

Douglas Service, Vol. 5, No. 12, December, 1947. 20 pp., illus.

Contents: Fuel System Management—Operation of Controls for 8- and 10-Tank Systems, DC-6. Inverter Operation, DC-6. Throttle Adjustment Template, DC-6. Control Surface Settings, DC-4. Lubrication Charts. Main Gear Shock Strut—Rework Tolerances for Inner Piston of Strut, DC-4. Fiberglas Laminate—Materials and Procedures Used for Various Repairs, DC-6. Water Tank Panels, DC-6. Low-Speed Supercharger Installation—Ground Maintenance (Centerspread), DC-6. Service Bulletins, DC-6. Advance Engineering Changes, DC-6. Air Duct Leaks—Repairs for Porous, Leaky or Broken Connections, DC-6. Supercharger Instrument Lines—Identification of Lines, DC-6. Cable Rigging Tension Chart. Fuel Tank Dip Sticks, DC-6.

Air Work; The Organization Behind the Many Activities of a Large Private Enterprise (Airwork Ltd.). Roy Pearl. *Flight*, Vol. 53, No. 2037, January 9, 1948, pp. 39–42, illus.

Electric Carburetor Air Temperature Gauge and System; A Case History. *Aviatian Service Magazine*, January, 1948, pp. 26, 27, 41, diagrs.

Management & Finance

Shall We Have Airplanes? I. *Fortune*, Vol. 38, No. 1, January, 1948, pp. 77–81, 157–162, illus. A survey of the financial and production status of the aircraft manufacturing industry and the postwar airplane market.

Report from Canada. *The Aeroplane*, Vol. 73, No. 1907, December 26, 1947, p. 825. An analysis of the Canadian market for British-produced aircraft.

A Sales Questionnaire. *The Aeroplane*, Vol. 73, No. 1906, December 19, 1947, p. 787.

A list of 25 specific questions on the first cost, depreciation, overhaul, maintenance, performance, and contract terms that should be answered by the sales promotion material of commercial aircraft manufacturers.

Accounting Problems of Operating Airlines. Leo R. Gilleran. *New York Certified Public Accountant*, Vol. 18, No. 2, February, 1948, pp. 132–138.

The chief accounting problems of air lines arise from the imposition of an uniform system of accounting by the C.A.B., the wide dispersal of the installations at which the air lines operate, and the rapidity with which procedures must be changed to keep pace with technical developments. Only with the development of precedents will air-line accounting be brought to conform to more normal varieties of accounting.

Airport Accounting. Joseph M. Cunningham. *New York Certified Public Accountant*, Vol. 18, No. 2, pp. 139–150.

Basic outline of an accounting system that will supply to the air-line operator and to the interested municipality the data they require for efficient airport operation.

British Aircraft Exports (January–October, 1947). *Flight*, Vol. 52, No. 2035, December 25, 1947, p. 726, illus.

Nominal Security Quotations Reflect Plight of Non-Scheds. Selig Altschul. *Aviation Week*, Vol. 48, No. 4, January 26, 1948, p. 39, table.

Materials

Statistical Aspects of Fracture Problems. Benjamin Epstein. *Journal of Applied Physics*, Vol. 19, No. 2, February, 1948, pp. 140–147, figs. 15 references.

A partial survey of the literature pertaining to the statistical relationship that exists between the strength of a specimen and its size. The "weakest link concept" is essentially the same as the statistical theory of the distribution of extreme values. The use of this mathematical statistical theory makes it possible to find not only the most probable value but also the actual distribution of the smallest value of strengths in a sample size n.

METALS & ALLOYS

The Problem of High Temperature Alloys for Gas Turbines. Sir William T. Griffiths. *Royal Aeronautical Society, Journal*, Vol. 52, No. 445, January, 1948, pp. 1–18, illus. 11 references.

A comprehensive summary of the strength and fatigue requirements, oxidation and corrosion resistance, and stability of materials to be used for blades, nozzle guide vanes, rotor discs, and combustion chambers of gas-turbine power plants. The first attempts to meet these requirements were confined to the ferrous metals, but gradually the field of research has expanded to include nickel, chromium, and other nonferrous metals. Progress in this development has reached a point where work must now be done to find out not only the fundamentals of creep in a metal, but also to determine the influence of metallographic factors and the influence of manufacturing history on the creep behavior of materials.

Selection of High Temperature Materials for Gas Turbines. Rebecca H. Smith. *The Iron Age*, Vol. 161, No. 4, January 22, 1948, pp. 56–60, illus.

A critical review of the factors governing the selection of materials for gas-turbine components which summarizes the methods of testing load-carrying ability, structural stability, fatigue strength, and ductility at elevated temperatures. Metallurgical

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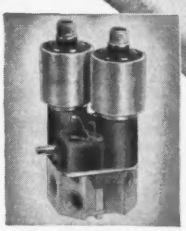

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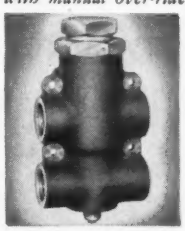

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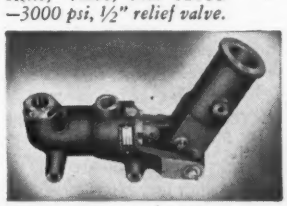

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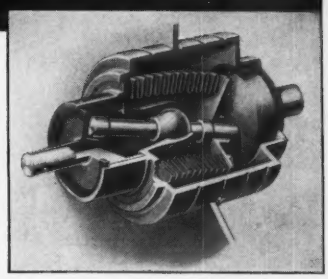

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factors, cost, and availability determine the selection of a particular material and its processing, forming, and finishing.

High-Temperature Oxidation. H. M. McCullough. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 38–41, illus.

Alloys for Severe High-Temperature Service. W. C. Leslie and D. J. McPherson. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 42–47, illus.

High-Temperature Equipment for Sintering Combinations of Ceramic Oxides and Metal Powders. A. R. Blackburn. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 24–28, illus.

Structural Evaluation of an Extruded Magnesium-Alloy T-Stiffened Panel. Norris F. Dow and William A. Hickman. *U.S., N.A.C.A., Technical Note No. 1518*, February, 1948. 17 pp., illus. 6 references.

Compressive tests were made of six different lengths of a ZK60A magnesium-alloy flat panel having skin and longitudinal T-section stiffeners extruded as one integral unit. The results indicated that the extruded panel had structural characteristics that were somewhere between those for 24S-T and those for 75S-T aluminum-alloy Y-stiffened panels, but, because of the integral nature of the extruded construction, it required far fewer rivets to assemble than either the 24S-T or the 75S-T panels with which comparisons were made. The height of the stiffeners was also somewhat less for the extruded panel.

Comparison of the Compressive Strength of Panels With Alclad 24S-T81 Sheet or With Alclad 24S-T86 Sheet Riveted to Alclad 24S-T84 Hat-Section Stiffeners. Robert A. Weinberger, Carl A. Rossman, and Gordon P. Fisher. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-587)*, April, 1944. 13 pp., illus. 1 reference.

Zicral—A New High-Tensile Light Alloy. P. Vachet. (*Revue de l'Aluminium*, Vol. 24, Nos. 134, 135, June–July, August, 1947, pp. 189–198; 225–233.) *The Engineers' Digest*, Vol. 5, No. 1, January, 1948, pp. 31–35, illus.

A summary of the chemical composition, physical properties, metallurgical structure, heat-treatment, corrosion resistance, and working properties of Zicral. This Al-Zn-Mg alloy, when heat-treated, has an elastic limit of from 28 to 38 tons per sq.in. and an elongation of from 9 to 15 per cent.

The Aluminum Industry of Japan. II—Light Metal Fabricating Industry, Including Copper and Copper Alloys. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.-P./P.R./932.* British Information Services, New York. $0.70.

A New Surface Treatment for Magnesium. A. L. Kohl and Herbert Waterman. *The Iron Age*, Vol. 161, No. 4, January 22, 1948, pp. 50–55, illus. 10 references.

A self-healing film is formed on magnesium alloys by anodizing the metal in a hot saturated sodium carbonate solution at about 115 volts. The white crystalline coating that is produced is an electrical insulator and is highly resistant to abrasion. It forms a good base for paint and affords corrosion resistance equal to or better than that obtained with chromate or dichromate treatments.

The Corrosion of Metals. VIII—Aluminum and Its Alloys. *Sheet Metal Industries*, Vol. 25, No. 249, January, 1948, pp. 135–142, diagrs. 10 references.

Corrosion and Its Causes. R. Kerr. *The Technical Instructor*, Vol. 2, No. 12, December, 1947, pp. 11, 12.

Passivation of Stainless Steel. F. H. Beck. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 32–38, illus. 1 reference.

Facilities and Activities in Metallurgical Research. Mars G. Fontana. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 3, 4. 1 reference.

Improved Metals Promise Design Progress. *Machine Design*, Vol. 20, No. 1, January, 1948, pp. 103–110, illus. Discussion of characteristics and applications of low-alloy, high-strength steels, high-alloy and super-alloy steels, and powder metals.

Dependence of the Stress-Strain Curves of Cold-Worked Metals Upon the Testing Direction. L. J. Klinger and G. Sachs. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 151–154, figs. 4 references. (Cf. AER 12/47:28.)

A Simple Theory of Static and Dynamic Hardness. D. Tabor. *Royal Society of London, Proceedings, Series A*, Vol. 192, No. 1029. February 4, 1948, pp. 247–274, diagrs. 27 references.

Experiments indicate that when a hard spherical indenter acts on a metal surface, the last stage of the indentation process is reversible and may be expressed in terms of the elastic constants of the materials and the sphere. It is shown that when an indentation is formed in a metal surface by an impinging indenter, the pressure resisting indentation is greater than that occurring in the formation of a similar indentation under static conditions, and that the higher the velocity of impact, the greater the pressure of resistance. This indicates a dependence of the yield pressure on the speed of deformation and suggests that in the dynamic deformation of metals, forces of a quasi-viscous nature are involved. A simple theory of hardness is developed in which the hardness of a metal is correlated with its elastic limit and the variation of the elastic limit with the amount of deformation to which the metal has been subjected. Reasonable agreement is obtained between hardness measurements and the stress-strain characteristics of various metals. It is also possible by this theory to explain the well-established empirical laws of Meyer.

On the Deformation of Metals and Alloys. J. Ternisien. (*La Metallurgie*, Vol. 79, No. 4, April, 1947, pp. 7–10.) *Engineers' Digest*, Vol. 4, No. 12, December, 1947, pp. 584–586, illus. 5 references.

The Vapor Pressure of Metals. Rudolph Speiser. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 12–20, illus. 6 references.

Metallic Titanium is Light, Strong, Durable, and Corrosion Resistant. E. A. Gee, J. R. Long, and W. H. Waggaman. *Materials & Methods*, Vol. 27, No. 1, January, 1948, pp. 75–78, diagrs.

Laboratory for Mechanical Testing at Very Low Temperatures. John L. Zambrow. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 4–9, illus.

Testing the Super-Alloys. T. Y. Wilson. *Instrumentation*, Vol. 3, No. 2, First Quarter, 1948, pp. 12, 13, illus. The equipment and techniques used in making time-to-rupture, creep, stress-corrosion, creep-relaxation, and fatigue tests.

Supersonic Flaw Detectors. Donald C. Erdman. *Electrical Engineering*, Vol. 67, No: 2, February, 1948, pp. 181–185, illus.

A Recording Dilatometer for Metallurgical Research. J. O. Lord. *Ohio State University, Engineering Experiment Station News*, Vol. 19, No. 5, December, 1947, pp. 9–11, illus.

Some Notes on Tensile Testing. Frank W. Sowa. *The Iron Age*, Vol. 161, No. 4, January 22, 1948, pp. 68, 69, diagrs.

During tensile testing, the interior portion of a ductile steel specimen is the first portion to be subjected to cold-working. This work hardening progresses to the outside surfaces of the specimen as the load approaches the maximum. Surface roughness therefore does not affect the yield point or the maximum load. Different rates of loading (1,200 to 60,000 lbs. per min.) do not adversely affect the cold-working that takes place, but tensile test loading rates between 1,200 and 20,000 lbs. per min. produced the greatest increase in the yield and maximum loads.

NONMETALLIC MATERIALS

The Choice of Adhesives for Assembly Work. *Aero Research Technical Notes, Bulletin No. 60*, December, 1947. 9 pp., illus. 7 references.

Aerolite is a urea formaldehyde resin adhesive. When it is used with GB hardener, it is gap filling, displays no catastrophic crazing, and will not deteriorate the wood. When the resin and the hardener are applied to the work in separate applications, a joint is produced which is stronger, more durable, and more resistant to heat and moisture cycles than conventional urea resins.

A Survey of Plastic Materials for Students; A Guide to Their Manufacture, Characteristics, Properties and Uses. III. G. Fitzgerald-Lee. *Aircraft Engineering*, Vol. 19, No. 224, October, 1947, pp. 321, 322. (Cf. AER 3/48:64.) Cellulose and miscellaneous thermoplastics.

Adhesives for Gluing Thin Metal Sheets. Francis A. Westbrook. *Steel Processing*, Vol. 34, No. 1, January, 1948, pp. 26–28, figs.

Adhesives and gluing techniques have been developed for the bonding of thin metal sheets. Except for copper and its derivatives the bonds obtained have been superior to those produced by riveting and welding.

Fiberglas Reinforced Plastics; Properties, Applications, Economics and Typical Manufacturing Methods. *Owens-Corning Fiberglas Corp., Fiberglas Standards A9.3.1*, December 23, 1947. 35 pp., illus., diagrs.

Ceramic Materials Show Promise for High Temperature Mechanical Parts. Joseph R. Bressman. *Materials & Methods*, Vol. 27, No. 1, January, 1948, pp. 65–70, illus.

A general discussion of the properties of ceramic materials for use at temperatures above 1,500°F., their fabrication and forming, and their use as coatings and as constituents of metal-ceramic materials.

Ceramic Coatings for High-Temperature Protection of Steel. Gilbert C. Close. *Steel Processing*, Vol. 33, No. 12, December, 1947, pp. 751–754, tables.

A report of laboratory and field tests by the National Bureau of Standards and the N.A.C.A. on an enamel frit suitable for the protection of the high-temperature portions of aircraft and automotive exhaust systems.

Fusion Properties of Various Types of Glass and Ceramic Materials With Different Expansion Coefficients. Klumb and Gohlke. (*Deutsche Versuchsanstalt für Luftfahrt, ZWB/FB/1203*, March, 1940.) *U.S., Air Force, Translation No. F-TS-4009-RE*, January, 1948. 9 pp., tables.

Meteorology

Recent Progress in the Measurement of Atmospheric Pressure. Frederick Koppl. *Review of Scientific Instruments*, Vol. 18, No. 11, November, 1947, pp. 850, 851, illus.

The quartz barograph employs an evacuated Bourdon tube of quartz glass as a pressure element. It is completely free from hysteresis and has absolute temperature stability. The hypsometer provides hysteresis-free temperature-stable operation accurate to within 0.02 mm. Hg under varying mechanical and acoustical conditions. This instrument measures the barometric pressure indirectly by deduction from the boiling point of distilled water measured by a resistance thermometer.

Temperature and Recombination in the Ionosphere. S. L. Seaton. *Journal of Meteorology*, Vol. 4, No. 6, December, 1947, pp. 197–200, figs. 11 references.

Viscosity and Thermal Conductivity of Air and Diffusivity of Water Vapor in Air. R. B. Montgomery. *Journal of Meteorology*, Vol. 4, No. 6, December, 1947, pp. 193–196, tables. 24 references.

Measurement of Rainfall by Radar. J. S. Marshall, R. C. Langille, and W. McK. Palmer. *Journal of Meteorology*, Vol. 4, No. 6, December, 1947, pp. 186–192, illus. 9 references.

Circulation and Convergence in the Equatorial Zone Between 95°E and 160°E: December to February. A. H. Glenn. *American Meteorological Society, Bulletin*, Vol. 28, No. 10, December, 1947, pp. 453–464, diagrs. 17 references.

The Fields of Temperature, Pressure, and Three-Dimensional Motion in Selected Weather Situations. Robert G. Fleagle. *Journal of Meteorology*, Vol. 4, No. 6, December, 1947, pp. 165–185, diagrs. 24 references.

Measurement of Ozone Over the Organ Mountains, New Mexico. Ralph Stair. *U.S., National Bureau of Standards, Journal of Research*, Vol. 40, No. 1, January, 1948, pp. 9–19, illus. 23 references. Available also as Research Paper No. RP1851. U.S. Govt. Printing Office. $0.10.

Measurements were made by the phototube and filter method in order to check the technique used by the Naval Research Laboratory in V-2 rocket experiments. Data agreed well with that obtained by others for the same latitude and season of the year.

Navigation

Economy Rules on Isobars. I, II. *The Aeroplane*, Vol. 74, Nos. 108, 109, January 2, 9, 1948, pp. 10–12; 39–41, diagrs.

I. The underlying theory of pressure-pattern flying and the method of computing a single-heading course. The use of a drift-angle computor and an adaptation of the normal Appleyard scale in this calculation are explained. **II.** The limitations and errors encountered in pressure-pattern flight planning, drift taking, and flight-plan amendments en route.

Operations

COMMERCIAL

Mechanical Handling of Air Freight. George H. Scragg. *Traffic World*, Vol. 87, No. 7, February, 1948, pp. 489–492, illus.

A survey of equipment and techniques developed by air-cargo carriers for the rapid and efficient handling of freight. Since speed is the most attractive feature of air-cargo transport the industry has adopted not only the labor and timesaving mechanical devices of the other cargo carriers but has designed special droppable freight containers and detachable fuselage sections.

What Part Shall Freight Forwarders Have in the Development of the Air Freight Industry? IV, V, VI. C. Allen Elggren. *Air Transportation*, Vol. 11, Nos. 5, 6, Vol. 12, No. 1, November, December, 1947; January, 1948, pp. 22–25, 34; 36–38; 20–22, 34; illus.

The Freight Forwarder's Stake in the Sky. John W. Moore. *Air Transportation*, Vol. 11, No. 6, December, 1947, pp. 28–30, 35, illus.

Air Cargo, Inc.—Past, Present, Future. Fred M. Glass. *Air Transportation*, Vol. 11, No. 6, December, 1947, pp. 8–10, 42, illus.

Forum for Air Cargo-Minded. *Air Transportation*, Vol. 12, No. 1, January, 1948, pp. 8–18, 31–34, illus.

Should Commercial Cargo Plane Users and the Military Pool Their Equipment? Hugh J. Knerr. *The Pegasus*, Vol. 11, No. 2, February 1948, pp. 1–4, 16, illus.

Certificated Lines Ask Monopoly on U.S. Governmental Air Travel. Charles Adams. *Aviation Week*, Vol. 48, No. 4, January 26, 1948, pp. 40, 42.

Progress of Civil Aviation in 1947. *Indian Aviation*, Vol. 31, No. 10, October, 1947, pp. 230, 232–234, 236.

British South American Airways Corporation Shows a Profit. *The Aeroplane*, Vol. 74, No. 1912, January 30, 1948, pp. 140, 141, tables.

B.E.A. Accounts Published; Loss on First Eight Months. *Modern Transport*, Vol. 58, No. 1501, January 3, 1948, p. 7, illus.

How B.O.A.C. Spent the Money. *The Aeroplane*, Vol. 74, No. 1910, January 16, 1948, pp. 65–67, illus. Summary of the financial report covering April 1, 1946, to March 31, 1947.

On the Non-Scheduled Front. *Air Transportation*, Vol. 11, No. 6, December, 1947, pp. 31, 32, 35, table.

Operational statistics including a list of 42 irregular air carriers grounded by the N.A.C.A. for noncompliance with economic regulations, and a tabulation of equipment used by nonscheduled operators which shows the number of aircraft by type, operations authorized, and the total number of pilots employed in the nine C.A.A. regions.

The Charter Business. David Brice. *The Aeroplane*, Vol. 74, No. 1912, January 30, 1948, pp. 138, 139, illus.

The Difficulties of Private-Charter Flying. Storm Back. *The Aeroplane*, Vol. 73, No. 1903, November 28, 1947, pp. 708–710, illus.

Post Office Air Mail Estimates Support Stand Against Rate Boost. *Aviation Week*, Vol. 48, No. 2, January 12, 1948, p. 40. Includes table: Post Office Dept. Domestic Airmail Estimates, Results for Fiscal 1947, 1948, 1949, and 1950 at Postage Rates of 8 Cents, 6 Cents and 5 Cents an Ounce.

MILITARY

NATS and ATC Are Merged Into Single Military Transport Service. Robert Hotz. *Aviation Week*, Vol. 48, No. 6, February 9, 1948, p. 10. Includes statistics for 1947.

Ordnance & Armament

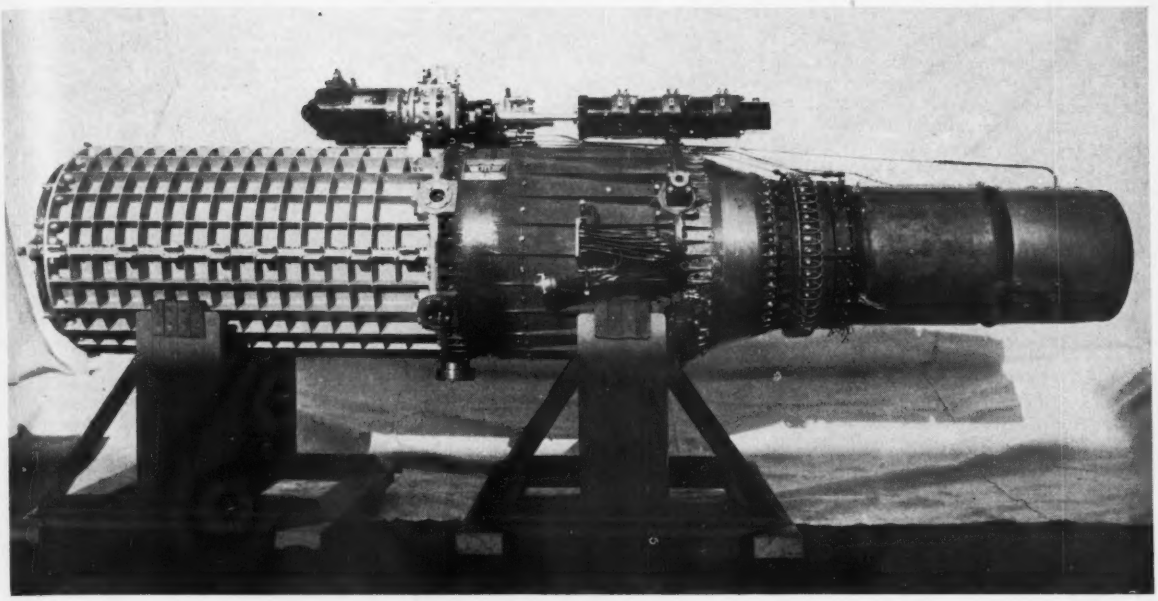
The German Development of Recoilless Guns for Aircraft. J. Corner. *Aircraft Engineering*, Vol. 19, No. 226, December, 1947, pp. 378, 379, 389, illus.

Armour of Japanese Airplanes. Sheldon W. Brown. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./894*, October 31, 1945. 5 pp., diagrs. British Information Services, New York. $0.35.

Personal Flying

Pity the Private Pilot. Harris G. Moe. *Aero Digest*, Vol. 56, No. 2, February, 1948, pp. 60–62, 121, illus.

With the equipment currently provided the private pilot is still forced for most of his long-distance navigation to depend on surface highway and railroad networks for landmarks. Only under ideal conditions can sources be computed and flown with accuracy.



One of America's latest jet engines, the Lockheed XJ-37, develops 8,000 hp. and can be used either as a pure jet engine or in a turbine-propeller combination. It was designed at Lockheed Aircraft Corporation, and contracts for testing and development have been awarded to the Wright Aeronautical Corporation.

Photography

Extremely Wide-Angle Lenses for Aerial Mapping. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 32, No. 1, January, 1948, pp. 5–7, illus. (Cf. AER 4/48:61.)

Reconnaissance Demonstration; Modern Aids to P.R. on Show at Benson: Radar for Air Survey. John Yoxall. *Flight*, Vol. 52, No. 2035, December 25, 1947, pp. 712–715, illus.

Field Calibration of the Fairchild Camera Transit Focal Length; Report Number 1 of Subcommittee on Terrestrial Photogrammetry. *Photogrammetric Engineering*, Vol. 15, No. 4, December, 1947, pp. 695–699, diagrs.

Test of Aerial Cameras and Multiplex Reduction Printers; Report 1 of Subcommittee on Multiplex Equipment Test. *Photogrammetric Engineering*, Vol. 13, No. 4, December, 1947, pp. 690–695, figs.

Power Plants

Electric Drive for Aircraft. George C. Crom. *Electrical Engineering*, Vol. 66, No. 12, December, 1947, pp. 1206–1208.

If turbogenerators in the fuselage of large long-range multi-engined aircraft served as a power supply and the propellers were driven by electric motors, the present size of engine nacelles could be reduced and the wings redesigned to reduce drag as much as 12 per cent. The number of generators in operation at any time could be chosen to correspond to the power requirements and permit each unit to operate at maximum efficiency. A substantial saving of fuel would result from this increase in aerodynamic and power-plant efficiency.

The Way of Achievement; Rolls-Royce Flight Development: A History of Modern Pioneering. II. C. B. Bailey-Watson. *Flight*, Vol. 53, No. 2040, January 29, 1948, pp. 123–128, illus.

Aircraft Power Plant Engineering; Development of British Companies. II. Frank Nixon. *Modern Transport*, Vol. 58, No. 1502, January 10, 1948, p. 9, illus.

Compounded Allison (V-1710-E-27), Experimental Unit With Feed-Back Turbine. *Flight*, Vol. 53, No. 2040, January 29, 1948, p. 130, illus.

Pressure Refueling. *The Aeroplane*, Vol. 74, No. 1908, January 2, 1948, pp. 20, 21, illus.

A discussion of the advantages of pressure refueling, pressure build-up and the shut-off of individual tanks, and the features of typical aircraft installations.

JET & TURBINE

The Ram-Jet as a Supersonic Propulsion Plant. W. H. Goss and Emory Cook. *Preprint, S.A.E. Annual Meeting*, Detroit, January 12–16, 1948. 30 pp., illus. 12 references.

Performance analysis of the ram-jet in terms of its stream thrust, operating temperature, and specific impulse. The high power per unit frontal area and per unit weight of the ram-jet engine, its mechanical simplicity and its high specific impulse in comparison with rockets make it ideal for sustained propulsion at supersonic speeds. Its practical development demands a more thorough knowledge of the aerodynamic and thermodynamic processes on which its operation depends.

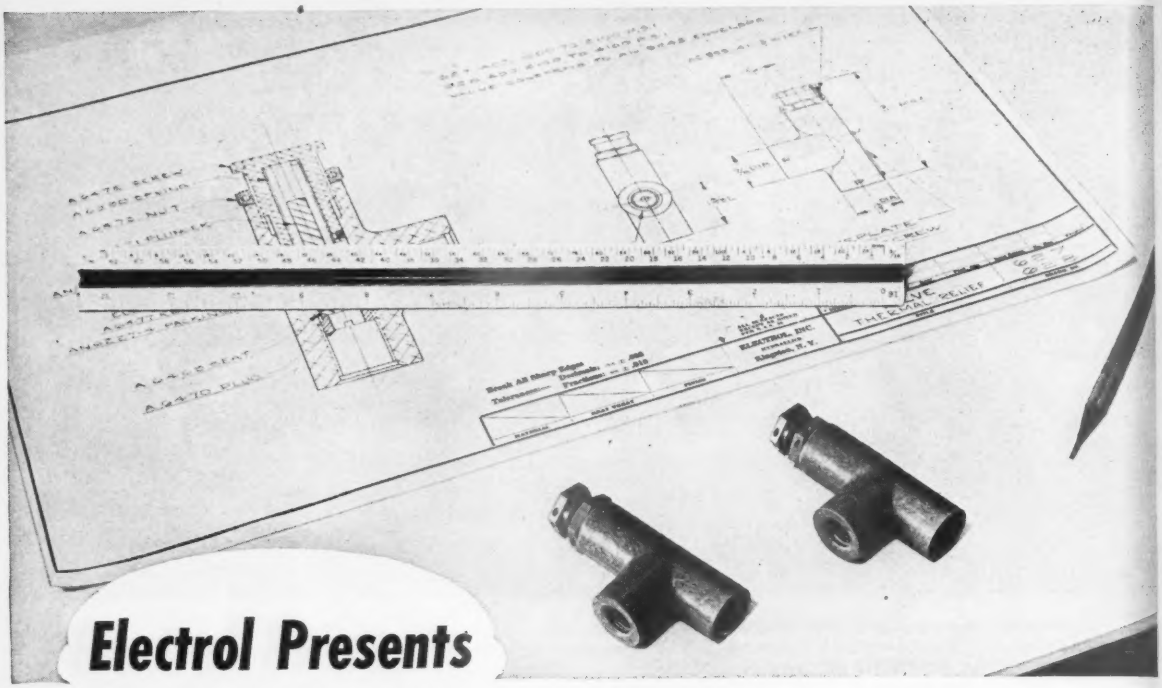
Navy Boosts Ram Jet Power; Aerojet Engineering Corp.'s 15-in. Model Shows Results of Wind Tunnel Test Progress. *Aviation Week*, Vol. 48, No. 6, February 9, 1948, p. 12, illus.

Measuring the Ramjet Helicopter. Witold B. Brozowski. *Aero Digest*, Vol. 56, No. 2, February, 1948, pp. 64–66, illus.

Theoretical calculation of the performance of a ram-jet power plant situated at the extreme tip of a helicopter rotor blade. Expressions are obtained for hovering and vertical flight, forward flight, and fuel consumption. Principal difficulties of this ram-jet application are the design of short, lightweight combustion chambers, compensation for the difference in the rate of delivery of the fuel-air mixture and the rate of travel of the combustion front, and the equalization of cross-sectional and longitudinal burning time within the combustion chamber.

Conditions for Choking in a Cylindrical Combustion Chamber With Eddying Pressure Losses. Frank H. Browning and James W. McConnaughhay. *California Institute of Technology, Jet Propulsion Laboratory, Memorandum No. 3-7 (Power Plant Laboratory Project MX527)*, June 30, 1946. 51 pp., figs. 2 references.

A trial-and-error method of determining, from given inlet conditions, the conditions for choking and the maximum possible fuel-air ratio. Results are accurate within about 0.5 per cent. The curves that are developed make it possible to determine for given conditions of temperature, velocity, and gas composition at the inlet of the combustion chamber the fuel-air ratio required to produce sonic velocity at the outlet. This fuel-air ratio is independent of the inlet pressure and density. For an approximate solution to the problem, the ratio of specific heats may be evaluated at the inlet to the combustion chamber and assumed to remain constant. Errors in the results thus obtained are generally small but may amount to over 10 per cent under conditions of low inlet temperature and high fuel-air ratio.



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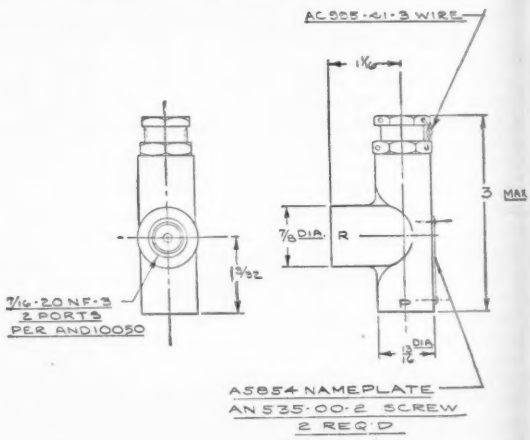

Diagrammatic sketch of Thermal Relief Valve.

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FOR BETTER HYDRAULIC DEVICES

Temperature Measurement on Two Stationary Bucket Profiles for Gas Turbines With Boundary-Layer Cooling. K. H. Kuepper. (*Deutsche Versuchsanstalt für Luftfahrt, ZWB/UM/1171*, February, 1944.) *U.S., Air Force, Translation No. F-TS-1543-RE*, January, 1948. 10 pp., diagrs.

Static tests of gas-turbine bucket profiles cooled by the emission of a layer of cold air tangentially to the blade surface in the direction of flow of the working fluid. The temperature differential between the cooled and uncooled profile is determined for two designs, one with five and another with seven cooling-air slots.

Aircraft Propelling Plant of the Future. R. Wild. (*Flugwehr und-Technik*, Vol. 9, No. 6, July, 1947, pp. 167, 168.) *Engineers' Digest*, Vol. 4, No. 12, December, 1947, p. 574.

Summary of the fuel consumption and efficiency characteristics of the piston, gas-turbine, turbojet, and rocket aircraft engines. A shift of interest can be foreseen from the reciprocating engine to the turbine engine driving propellers, and, when speed requirements have risen sufficiently, to the turbojet engine as well.

A Simple Method of Performance Calculation for Aircraft With Gas Turbine Power Plant. P. Maeder. (*Flugwehr und-Technik*, Vol. 9, No. 4, April, 1947, pp. 104–106.) *Engineers' Digest*, Vol. 5, No. 1, January, 1948, pp. 29, 30, figs.

An equation involving the full-load thrust, a throttling characteristic, and the angle of inclination of the flight path is taken as the basis of development in thrust-drag diagram. This approach results in a considerable simplification of the performance calculation for turbine-powered aircraft.

Fuel Systems for the Aero-Gas Turbine. II. E. A. Watson. *The Engineer*, Vol. 184, No. 4795, December 19, 1947, pp. 576, 577, diagrs. (Cf. AER 4/48:62.)

The mechanics of atomization and the theoretical determination of the discharge coefficient and cone angle of the spray. In order to provide for a wide flow range, the Lubbock, the Duplex, and the spill-type atomizers have been developed.

Regulating Methods for Gas Turbines. II. B. Gumpert and M. Haubenhofer. *Interavia*, Vol. 2, No. 12, December, 1947, pp. 44–46, illus.

General features of systems for fuel measuring and regulation and control. Functional difficulties observed in a BMW system for regulating the r.p.m and for controlling the jet nozzle setting of the 003 jet engine are detailed. Combustion-chamber temperature is a disadvantage of present control systems.

The Estimation of Stresses in Turbine-Disc Rims. I, II. G. F. C. Rogers. *Engineering*, Vol. 165, Nos. 4275, 4276, January 2, 9, 1948, pp. 1–4; 40–43, diagrs.

I. Curves are developed for the rim stresses which show that for solid tapered discs the shear stress is low compared to the rim bending stress and to the shear stress in the disc hoop. For a given disc hoop stress and a given increase in rim thickness, the overhang of the rim may be increased without the rim bending stresses being increased over the disc hoop stress. **II.** Examples illustrate the application of this method to the type of loading that occurs in compressor discs and two-stage turbine discs.

Dynamic Stress Tests on Impeller for Axial-Flow Compressors. Wiemann. (*Daimler-Benz Werk 60, Untertuerkheim, DB/VER/170-004*, December, 1943.) *U.S., Air Force, Translation No. F-TS-2680-RE*, January, 1948. 11 pp., illus.

The keyway in turbine-blade rings was found to constitute a hazard in that it warps the ring. A modification of the design (SKVZ 150) was run to 18,000 r.p.m., 50 per cent above normal. Only at this value did permanent deformations occur in the retainer pins of the substitute blades.

Enemy Jet History. D. R. Maguire. *Royal Aeronautical Society, Journal*, Vol. 52, No. 445, January, 1948, pp. 75–84, illus. 5 references.

A summary of gas-turbine, turbojet, and ducted-fan developments in Germany, Italy, and Japan prior to the close of World War II. The characteristics of the engines developed by the German firms Heinkel, B.M.W., Junkers, and Daimler-Benz and the aircraft developed by Heinkel, Messerschmitt, and Arado are tabulated.

Jet Engine Development in Canada. P. B. Dilworth. *The Engineering Journal*, Vol. 30, No. 12, December, 1947, pp. 582–586, illus. Historical.

West Coast Predicts Gain in Military Ram Jet Knowledge. Scholer Bangs. *Aviation Week*, Vol. 48, No. 6, February 9, 1948, p. 17.

Northrop Turbodyne. Andrew R. Boone. *Air Trails Pictorial*, Vol. 30, No. 4, January, 1948, pp. 44, 45, 102, 103, illus.

A Fuel System Full-Scale Testing Rig. A. Black, D. J. Stewart, and G. Powell. *Aircraft Engineering*, Vol. 19, No. 225, November, 1947, pp. 340–346, illus.

Design and operation both of a fuel system to provide continuous supply to gas-turbine engines from a number of fuel tanks and of a test rig for full-scale testing of this system. Air pressure is used to force the fuel from the individual storage tanks to a central collector tank. Submerged booster pumps at the top and bottom of the collector tank supply fuel to the engine. The top pump, which only operates when the tank is subjected to negative gravitational forces, provides a constant fuel supply during acrobatics.

Construction and Operation of Test Stands for BMW 003 Turbojet Engines. Zeilinger. (*Berlin-Spandau U58*, December, 1944.) *U.S., Air Forces, Translation No. F-TS-2836-RE*, January, 1948. 11 pp.

Twisting a Turbine's Tail. *Popular Science Monthly*, Vol. 152, No. 1, January, 1948, pp. 142, 143, diagr.

Cutaway schematic drawing of the gas-turbine development laboratory operated by the Wright Aeronautical Corporation at Wood-Ridge, N.J. The installation is capable of measuring power out-puts up to 20,000 hp.

Turbojet Development Laboratory. Winston R. New. *Aero Digest*, Vol. 56, No. 2, February, 1948, pp. 64–66, illus.

The equipment and facilities of the subdivisions of the Westinghouse laboratory at South Philadelphia set up under the sponsorship of the Bureau of Aeronautics for the testing and engineering development of components of gas-turbine power plants.

Turbine Torture Chamber. George E. Slye. *The Bee-Hive*, Vol. 23, No. 1, January, 1946, pp. 13–16, illus.

RECIPROCATING

Preignition and Its Deleterious Effects in Aircraft Engines. A. Hundere and J. A. Bert. *Preprint, S.A.E. Annual Meeting*, Detroit, January 12–16, 1948. 24 pp., illus. 15 references.

Preignition is a far more prevalent cause of engine failure than detonation. Spark plugs, because of the high temperatures at which they must operate, are the most common hot spots to act as a source of preignition. Combustion chamber deposits are secondary in importance. Preignition-limited performance data for a wide range of fuel types indicate little difference between fuels compared with the differences in detonation-limited performance. Lead-tetraethyl fuel additives tend to decrease the tendency for preignition by metallic hot spots. However, this desirable effect is believed to be completely offset by the formation of combustion chamber deposits that will themselves cause preignition. Experimental and service examples of exhaust-valve failure, blow-by, cylinder head burns, and defective spark plugs illustrate the deleterious effects of preignition on aircraft engines.

Effect of Inlet-Air Velocity Distribution on the Metering Pressure of an Injection-Type Aircraft Carburetor. George F. Kinghorn. *U.S., N.A.C.A., Advance Restricted Report* (*Wartime Report No. L-768*), May, 1942. 35 pp., illus. 2 references.

Ground-Stand Cooling Investigation of an R-2600-22 Engine in a PBM-3D Nacelle. Robert C. Spencer, F. William Petring, and William R. Prince. *U.S., N.A.C.A., Memorandum Report No. L5L18* (*Wartime Report No. L-754*), January, 1946. 49 pp., illus. 8 references.

Review of Flight Tests of NACA C and D Cowlings on the XP-42 Airplane. J. Ford Johnstone. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-613*), April, 1943. 48 pp., illus. 11 references.

An Investigation of the Ranger V-770-8 Engine Installation for the EDO XOSE-1 Airplane. I—Cooling. Robert N. Conway and M. Arnold Emmons, Jr. *U.S., N.A.C.A., Memorandum Report No. L5I12* (*Wartime Report No. L-561*), October, 1945. 65 pp., illus. 7 references.

Upturned Leonides (Alvis). *Flight*, Vol. 53, No. 2037, January 9, 1948, p. 43, illus.

Stratocruiser Turbosupercharger and Power Plant. *Boeing Service Guide*, No. 4, January, 1948, pp. 5–11, illus.

Cheetah Genealogy (Armstrong Siddeley); Fifteen Years' Development Have Led to the 475 h.p. Mk. 25: Association With Training. *Flight*, Vol. 52, No. 2035, December 25, 1947, p. 732, illus.

Latest Bristol Piston Engines; Some Details of the Civil Hercules and Centaurus Series. *Flight*, Vol. 53, No. 2037, January 8, 1948, pp. 32, 33, figs. Includes performance and fuel-consumption curves.

Power Plant Engineering; British Engine Firms' Self-Contained Engine Installations. Frank Nixon. *Flight*, Vol. 52, No. 2034, December 18, 1947, pp. 695–697.

ROCKET

Liquid Propellant Rocket Power Plants. M. J. Zucrow. *American Rocket Society, Journal*, No. 72, December, 1947, pp. 26–44, illus. 4 references. (See AER 2/48:59.)

Liquid Rocket Motor Testing. Robertson Youngquist. *American Rocket Society, Journal*, No. 72, December, 1947, pp. 45–55, diagrs.

A brief discussion of the problems involved in testing rocket motors. The design and equipment of test installations, test methods and instrumentation are outlined. Specimen test results are given.

Hydraulic Adjustment of Fuel-Injection Nozzle and Adjustable Thrust Bullet for P 3390 A Rocket Engine. Heinrich Koeck. (*BMW Flugmotorenbau G.m.b.H., BMW/3390 A/9-2-43*, February, 1943.) *U.S., Air Force, Translation No. F-TS-2732-RE*, January, 1948. 4 pp., diagrs. A hydraulic system which links the adjustable thrust nozzle and the fuel-injection nozzle to maintain constant combustion-chamber pressure.

Rocket Assisted Take-Off vs Pressure Tube Catapult. *Plane Facts*, Vol. 4, No. 6, December, 1947, pp. 4–6, illus.

The advantages and disadvantages of the JATO unit compared with a fixed catapult installation using a piston driven by the expansion of high-pressure gas in a closed tube.

Production

Manufacture of the de Havilland Dove Light Transport. *Aircraft Engineering*, Vol. 19, No. 226, December, 1947, pp. 393–401, 404, illus.

The Brabazon I—Its Hangar & Runway. Conclusion. *Airports & Air Transportation*, Vol. 2 (New Series), No. 55, December, 1947, pp. 213–215.

Laminar Flow Wing Proven in AW-52 Test Flights. *Aircraft and Airport*, Vol. 10, No. 1, January, 1948, pp. 18, 20, diagr.

The construction and production techniques used in the manufacture of the laminar-flow wing of the AW-52 by Armstrong Whitworth. Suction is used to control boundary-layer separation.

Profile Turning; German and English Methods of Machining Cams and Similar Profiles. *Aircraft Engineering*, Vol. 19, No. 225, November, 1947, p. 367, illus.

Simplifying the Drilling of Marked Off Holes. H. Moore. *Aircraft Engineering*, Vol. 19, No. 225, November, 1947, p. 366, diagrs.

High Speed Machining of Aluminum. R. L. Templin. *The Iron Age*, Vol. 161, No. 4, January 22, 1948, p. 61, table. (Extended abstract of a paper, "Development of a High Speed Lathe for Machining Aluminums.")

Bending and Forming of 75S-T Aluminum at Elevated Temperatures. M. L. Ochieano. *Machinery*, Vol. 54, No. 5, January, 1948, pp. 158–161, illus.

When heated to temperatures not exceeding 300°F., 75S-T aluminum alloy possesses formability equal to that of 24S-T. The Lockheed Aircraft Corporation uses inexpensive resistance heating units to take advantage of this property in the production of aircraft structural elements.

The Pressure Welding of Light Alloy Bar Without Fusion. R. F. Tylecote. *Sheet Metal Industries*, Vol. 25, No. 249, January, 1948, pp. 155–160, 162, 164, illus. 1 reference.

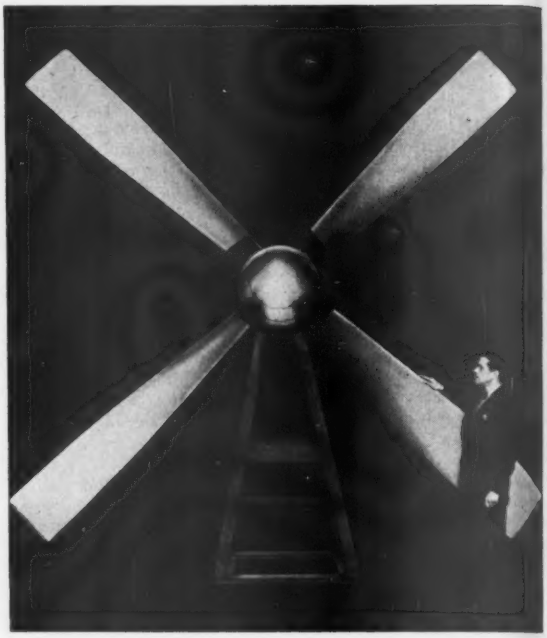
Testing of Electrically Welded Constructional Components of Aluminum Alloys. (*Schweizer Archiv*, Vol. 13, No. 7, July, 1947, pp. 202–210.) *Engineers' Digest*, Vol. 5, No. 1, January, 1948, pp. 27, 28, illus.

Results of a series of 76 tests to determine the optimum conditions for the manufacture of the bottom part of a 12-cylinder aircraft-engine casing by using arc welding instead of casting.

Welding in the U.S. Aircraft Industry. II. R. Grimaud. *Aircraft Engineering*, Vol. 19, No. 225, November, 1947, pp. 361–365, diagrs. (Cf. AER 3/48:71.)

Aeromatic Welding Procedures Lower Hub Costs. *Aviation Week*, Vol. 48, No. 5, February 2, 1948, pp. 24–27, illus.

Design description of light-plane propeller hubs manufactured by the Aeromatic Propeller Division of Koppers Company. The principal components are arc weldings rather than machined forgings.



Thomas B. Rhines, a Member of the Institute and Chief Development Engineer of the Hamilton Standard Propellers Division, displays the first of the Division's new line of 16½-ft. propellers for large transports.

The Extrusion Molding Process. H. B. Cook, from the Research Records of Charles C. Misfeldt. *The Iron Age*, Vol. 161, Nos. 5, 6, January, February, 1948, pp. 62–69; 78–86, 134; illus.

I. General description of the process and a comparison with other forming methods. Reproducibility of metallurgical characteristics and close tolerances suit the production of gas-turbine blades. II. Extrusion molding is not a substitute for die casting or forging but a separate process by which it may be possible to develop metals and alloys with improved high-temperature properties. The grain structures of Be-Cu alloys in the rolled and extruded forms and various cast forms and their physical properties are described. Recent refinement in the determination of the proportional limit of materials offers an improved design criterion for the strength of castings. Includes discussion of machines and equipment required for extrusion molding.

Quality by Statistics (Hamilton Standard Propellers). *The Bee-Hive*, Vol. 23, No. 1, January, 1948, pp. 23, 24, illus.

Propellers

Static-Thrust and Torque Characteristics of Single- and Dual-Tractor Propellers. Jean Gilman, Jr. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-750)*, June, 1944. 52 pp., illus. 5 references.

Safe Take-Offs in Cases of Engine Failure. *Interavia*, Vol. 2, No. 12, December, 1947, pp. 43, 44, illus. Description of the components and operation of automatic engine cut-out and propeller-feathering systems.

Wind-Tunnel Investigation of Alternative Propellers Operating Behind Deflected Wing Flaps for the XB-36 Airplane. Emanuel Boxer. *U.S., N.A.C.A., Memorandum Report No. L5K12a (Wartime Report No. L-533)*, December, 1945. 46 pp., illus. 2 references.

Static Characteristics of Curtiss Propellers Having Different Blade Sections. Blake W. Corson, Jr., and Nicholas Mastrocola. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-568)*, August, 1941. 46 pp., illus. 7 references.

Wind-Tunnel of Wickwire-Spencer Propeller. E. Floyd Valentine and Nicholas Mastrocola. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-770)*, March, 1942. 25 pp., illus.

Overhauling Beechcraft Electric Propellers. II. *Canadian Aviation*, Vol. 21, No. 2, February, 1948, pp. 42, 46, 68, diagrs.

Reference & Bibliography

Report Index on German Aeronautical Research Documents. Charles S. Weaver. *U.S., Field Information Agency, Technical, Final Report No. 948*, April 22, 1947. 104 pp. British Information Services, New York. $3.00.

A complete list, with English and German titles, of the research papers that appeared in the publications of the Z.W.B. during the period 1939 through 1942. The 832 reports listed cover general aeronautical subjects, electronics, communications, photography, optics, mechanics, chemistry, metallurgy, meteorology, and medicine. The titles are listed in the same sequence in which they appear in the annual volumes of the Jahrbuch der Deutschen Akademie der Luftfahrtforschung and the Jahrbuch der Deutschen Luftfahrtforschung, beginning with the earliest volumes. The list is equivalent to a reproduction and translation of the tables of contents of the several volumes. References are also made to abstracts in the D.A.L. Schriften and Mitteilungen. Page numbers refer to the pages in the annual volumes on which the papers begin. An arbitrary serial number has been assigned to each paper. Provision for a subject approach and inclusion of the names of authors would have made the index a more useful reference tool.

Aero Knowledge Now Integrated; Standard Aeronautical Index—New Abstracting and Cataloging Project—Collects, Screens, and Distributes Technical Data. Leslie E. Neville. *Aviation Week*, Vol. 48, No. 6, February 9, 1948, pp. 26, 29.

Rotating Wing Aircraft

Effect of Rotor-Blade Twist and Plan-Form Taper on Helicopter Hovering Performance. Alfred Gessow. *U.S., N.A.C.A., Technical Note No. 1542*, February, 1948. 26 pp., figs. 3 references.

A strip-analysis procedure is used to calculate the effect of twist and plan-form taper on rotor efficiency in hovering. The comparison is made for rotors of equal solidity, the solidities of the tapered blades being computed by means of an equivalent chord. A 5 per cent increase is shown over rectangular blades if both linear twist ($-8°$ to $-12°$) and taper ratio of root to tip chords of 3) are applied. An additional 2 per cent gain is shown for a nonlinear optimum combination of twist and taper. Moderate changes in solidity did not significantly affect these results.

Calculating the Longitudinal Stability and Control of Helicopters. Walter Just. *Interavia*, Vol. 2, No. 12, December, 1947, pp. 31–38, diagrs. 3 references.

A simplified mathematical analysis of rotor aerodynamics, rotor control, and the dynamic longitudinal stability of the helicopter. The characteristic equation that is developed is applied to two helicopters. The calculation for dynamic longitudinal stability agrees well with measurements made in flight.

Engine-Off Landings. II. Fitzwilliams. *Flight*, Vol. 52, No. 2080, November 20, 1947, pp. 582–584, figs. (Extended abstract of a paper: "Some Work With Rotating-Wing Aircraft.")

An analysis of the characteristics of helicopter rotors under engine-off conditions. A landing technique is proposed in which the helicopter can be maneuvered with engine off and so as to land in a 30- to 40-m.p.h. steep glide.

U.S. Navy's new experimental helicopter, the XHJS-1, developed by the Sikorsky Aircraft Division, United Aircraft Corporation. It has several new design features, including all-metal rotor blades, an improved engine-cooling system, nylon fuel cells, and a shock-mounted tail pylon that gives full head clearance under the tail rotor blades.

Helicopter Vibration Isolation. Bartram Kelley. *Preprint, SAE Annual Meeting*, Detroit, January 12–16, 1948. 8 pp., illus. 1 reference.

An analysis of a helicopter rotor with rigid blades supported by a flexible pylon in terms of a series of masses and springs. Formulas are given for which the characteristics of the elements can be determined and the conditions of minimum vibration established. Experiments showed that this method of vibration isolation can make cockpit vibration at a forward flight speed of 25 m.p.h. unobjectionable.

Helicopter Controls for Pitch-Power Coordination. A. F. Donovan and H. Hirsch. *Preprint, SAE Annual Meeting*, Detroit, January 12–16, 1948. 21 pp., diagrs. 3 references.

Sudden pitch changes of helicopter rotors without corresponding throttle adjustments produce dangerous changes in rotor r.p.m. Therefore, coordinated operation of the pitch and throttle controls is essential. Mechanical interconnection with provisions for manual or automatic adjustment of the relative control settings is the most satisfactory approach to the problem. The incorporation of a dead-center bellcrank-link arrangement in the pitch system to linearize the parabolic pitch-torque relation of the rotor and the use of a cam to linearize the torque-throttle relation of the engine make it possible to interconnect directly the two control systems at the main pitch-throttle control stick. With this combined system the r.p.m. of the rotor is substantially unaffected by change in rotor pitch.

Airfoil Section Data From Tests of 10 Practical-Construction Sections of Helicopter Rotor Blades Submitted by the Sikorsky Aircraft Division, United Aircraft Corporation. Neal Tetervin. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-643)*, September, 1944. 138 pp., illus. 7 references.

Full-Scale-Tunnel Performance Tests of the PV-2 Helicopter Rotor. Eugene Migotsky. *U.S., N.A.C.A., Memorandum Report No. L5C29a (Wartime Report No. L-545)*, April, 1945. 51 pp., illus. 2 references.

Unique Rotor Affords New Safety. Giles N. Montgomery. *Aviation Week*, Vol. 48, No. 4, January 26, 1948, pp. 28–30, diagrs.

The rotor system developed by Doman Frasier Helicopters, Inc., has eliminated the flapping hinge bearing and minimized the difficulties introduced by the Coriolis effect by using fixed blades attached to a tiltable hub driven through a constant velocity joint and gymbal ring universal joint.

New Rotor Suppresses Vibration. Giles N. Montgomery. *Aviation Week*, Vol. 48, No. 5, February 2, 1948, pp. 21, 22, 27, illus.

An explanation of the action of the conventional and the Doman helicopter rotor and blade in which the blade has a very low natural frequency and is of limber, light-weight construction.

Hiller Activities. *The Aeroplane*, Vol. 73, No. 1903, November 28, 1947, pp. 701, illus.

Servo Control; Helicopter Stability Achieved in New Hiller 360: "Finger-Tip" Loads on the Stick. *Flight*, Vol. 53, No. 2037, January 9, 1948, pp. 44, 45, illus.

Flying in the Irvin-Bell Helicopter (Model 47). *The Aeroplane*, Vol. 74, No. 1909, January 9, 1948, pp. 42–44, illus. Includes cutaway drawings of the control system.

Britain's First Commercial Helicopter: The Bristol Type 171—Mark 1. *Airports and Air Transportation*, Vol. 2 (New Series), No. 55, December, 1947, pp. 224–226, illus.

Bristol Type 171, A New British Helicopter. *Shell Aviation News* (London), No. 114, December, 1947, pp. 20, 21, illus.

A Helicopter for the Masses (Pentecost Hoppicopter.) B. K. Barclay. *The Aeroplane*, Vol. 74, No. 1910, January 16, 1948, pp. 68, 69, illus.

In Memory of a Pioneer; Cierva's Work on Rotating-Wing Aircraft. *Flight*, Vol. 53, No. 2037, January 8, 1948, pp. 27–29, illus.

How the Helicopter Got That Way. Igor I. Sikorsky. *The Bee-Hive*, Vol. 23, No. 1, January, 1948, pp. 25–27, illus.

What Makes the Helicopter Tick? Alexander Klemin. *Aero Digest*, Vol. 56, No. 2, February 1948, pp. 51, 79–80, illus.

Summaries of papers delivered at the Helicopter Symposium held by the S.A.E. Philadelphia Local Section: Ejection Cooling of the XR-10 Helcicopter Power Plant; Bevel Gear Test Experience; Testing of Helicopter Drive Systems; and Bearings in Action—Plague of Friction Oxidation.

Safety & Rescue

Plane Crash Fire Danger Studied by Fuel Engineers. W. E. Kuhn. *Aviation Week*, Vol. 48, No. 3, January 19, 1948, pp. 24, 25, illus.

Tests were conducted by the Texas Company with a number of fuels and distillation ranges to establish a criterion for the flammability of aviation fuels. The occurrence of fire for any given fuel was found to depend on the volatility of the fuel, the distance from the crash point to the source of ignition, and the ambient temperature.

Operational Safety Increase Seen As Major Aviation Need. Jerome Lederer. *Aviation Week*, Vol. 48, No. 7, February 16, 1948, pp. 17–20, tables.

Safety First. T. Neville Stack. *Flight*, Vol. 53, No. 2036, January 1, 1948, p. 18.

Safe operation of aircraft requires meticulous preflight inspection and maintenance in spite of the impatience of passengers, unhesitating cancellation of flight when necessary, ample fuel reserve, and correct loading practice.

Let's Learn to Fly With Safety. Arnold Warren. *Canadian Aviation*, Vol. 21, No. 2, February, 1948, pp. 22, 23, 66, illus.

The low accident rate during training shows that the subsequent increase can be attributed to ignorance, overconfidence, or lack of prudence on the part of the new pilot. Not engine failure nor forced landings but loss of control, which is usually attributable to pilot error, is the most important cause of fatal accidents.

Japanese Naval Aircraft CO_2 System Design. G. F. Beardsley. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./411*, November 6, 1945. 6 pp., diagrs. British Information Services, New York. $0.35.

Sciences, General

MATHEMATICS

Mathematical Solution of Complex Natural Values. Wielandt. (*Göttingen, Aerodynamische Versuchsanstalt, ZWB/FB/1806-1*, May, 1943.) *U.S., Air Force, Translation No. F-TS-1510-RE* January, 1948. 12 pp. 7 references.

A method of solving by determinants the transcendental equation of a complex matrix and the derivation of a number of characteristic natural values of matrices containing positive imaginaries. The method is applicable to vibration and flutter calculations. A fourth order equation can be solved in approximately 30 min.

Automatic Integration of Linear Sixth-Order Differential Equations by Means of Punched-Card Machines L. F. Hausman and M. Schwarzschild. *Review of Scientific Instruments*, Vol. 18, No. 12, December, 1947, pp. 877–883, tables. 3 references.

An Electronic Differential Analyzer. J. S. Koehler. *Journal of Applied Physics*, Vol. 19, No. 2, February, 1948, pp. 148–155, diagrs.

The Eniac. J. G. Brainerd and T. K. Sharpless. *Electrical Engineering*, Vol. 67, No. 2, February, 1948, pp. 163–172, diagrs. 1 reference.

MECHANICS

Torsional Vibration Frequency. Frederic P. Porter. *Machine Design*, Vol. 20, No. 1, January, 1948, pp. 153–156, diagrs.

Stress Analysis & Structures

Effects of Cutouts in Semimonocoque Structures. P. Cicala. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 171–179, diagrs. 9 references. (Cf. AER 1/48:29.)

Stresses in and General Instability of Monocoque Cylinders With Cutouts. IV—Pure Bending Tests of Cylinders With Side Cutout. N. J. Hoff, Bruno A. Boley, and Louis R. Viggiano. *U.S., N.A.C.A., Technical Note No. 1264*, February, 1948. 91 pp., illus. 6 references.

Stress-distribution results of pure bending tests of nine 24S-T Alclad cylinders of 20-in. diameter, 30- to 90-in. length, and 0.012-in. wall thickness, reinforced with 24S-T aluminum-alloy stringers and rings. On one side of the cylinder, situated symmetrically with respect to its horizontal plane of symmetry, there was a cutout extending over 12.9 in. or 19.3 in. in the longitudinal direction and over an angle of 45°, 90°, or 135° in the circumferential direction. The strain in the stringers and in the sheet covering was measured with metalelectric strain gages. All nine cylinders failed in general instability.

Some Elementary Considerations of the Stress-Strain Curve. R. M. Howarth. *Aircraft Engineering*, Vol. 19, No. 226, December, 1947, pp. 372–377, figs.

A general exposition of the characteristics of stress-strain curves. Below the limit of proportionality the accuracy of the curve depends primarily on the accuracy of the tests and the methods of interpreting the test from which the curves are plotted. Above the limit of proportionality the shape of the test specimen and the testing technique affect the stress-strain curve. A test technique of proof stress determination is suggested which is not affected by the "double modulus" or errors in the slope of the line of proportionality.

On the So-Called Principle of Least Work Method. II. M. Z. Krzywoblocki. *Franklin Institute, Journal*, Vol. 244, No. 6, December, 1947, pp. 465–469, diagrs. 3 references. (Cf. AER 6/47:55.)

Expressions for the equilibrium state of a structural system according to the Principle of Least Work and according to the Theorem of Minimum Potential Energy can be shown to be completely analogous, and even identical, by using the transformation methods of the calculus of variations. When applying the Theorem of Least Work to structural systems in which there are continuous distributed stresses a solution may be obtained by assuming the curve or surface representing in the first approximation the distribution of stresses to be a two-dimensional curve function or a three-dimensional surface function of the system of coordinates. The unknown coefficients of the functions chosen may be determined by using the Theorem of Minimum Strain Energy. An alternative method of solution is the application of calculus of variations.

The Design of Simplified Structures for Low-Cost Aeroplanes. A. Z. Boyajian. *Aircraft Engineering*, Vol. 19, No. 225, November, 1947, pp. 347–352, illus. (See AER 7/46:18.)

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SLOW QUENCH
14S-T6
61S-T6
The manufacturer utilizing a rapid quench with Alcoa 14S or 61S may be overlooking an opportunity. These alloys, when artificially aged, are relatively insensitive as regards effect of quenching rate on corrosion resistance; they can, in many cases, be quenched at slower rates (in the neighborhood of 100° per second) with results advantageous to further manufacturing operations.
FAST QUENCH
24S-T4
As the industry now generally recognizes and practices, a rapid (cold water) quench should be utilized with Alcoa 24S, because of its corrosion sensitivity to slow quench.
75S
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Note on Rayleigh's Method and the Non-Uniform Strut. H. A. Lang. *Quarterly of Applied Mathematics*, Vol. 5, No. 4, January, 1948, pp. 510, 511. 2 references.

Preliminary Data on Buckling Strength of Curved Sheet Panels in Compression. Eugene E. Lundquist. *U.S., N.A.C.A., Advance Restricted Report (Wartime Report No. L-690)*, November, 1941. 12 pp., diagrs. 3 references.

On the Stresses in a Plate Containing Two Circular Holes. Chih-Bing Ling. *Journal of Applied Physics*, Vol. 19, No. 1, January, 1948, pp. 77–82, figs.

Suitable biharmonic functions that give no stress at infinity are added to the stress system for the case of all-around tension, longitudinal tension, and transverse tension. Bipolar coordinates are used to obtain the parametric coefficients which are adjusted so as to satisfy the boundary conditions at the edges of the holes. Using formulas for the stress along the edge of the holes, the maximum stresses in the plate are calculated and plotted against the distance between the holes.

Strength of Thin-Web Beams With Transverse Load Applied at an Intermediate Upright. L. Ross Levin. *U.S., N.A.C.A., Technical Note No. 1544*, February, 1948. 20 pp., diagrs. 1 reference.

Results of tests of several 24S-T aluminum-alloy beams. A method of computing stresses and predicting failures in these directly loaded uprights is presented. Experimental and calculated results are compared.

Calculation of Uncoupled Modes and Frequencies in Bending or Torsion of Nonuniform Beams. John C. Houbolt and Roger A. Anderson. *U.S., N.A.C.A., Technical Note No. 1522*, February, 1948. 75 pp., diagrs. 5 references.

A simple iteration procedure using numerical integration for the accurate calculation of frequencies and modes (the higher modes as well as the fundamental) of nonuniform beams in bending or torsional vibration. All computations can be performed mentally or with the aid of a slide rule. The frequency is found from a simple ratio. The method applies to nearly all types of beams.

On the Interpretation of Combined Torsion and Tension Tests of Thin-Walled Tubes. W. Prager. *U.S., N.A.C.A., Technical Note No. 1501*, January, 1948. 11 pp. 9 references.

The Design of Oscillating Cantilevers. B. T. Turner. *Aircraft Engineering*, Vol. 19, No. 226, December, 1947, pp. 385–387, illus. 7 references.

Methods for the design and construction of a light-alloy cantilever to be oscillated at high frequencies which will have small deflections at the tip and a minimum rotational moment of inertia. It was found that the natural frequency of vibration could be safely determined for first check calculations by assuming a mean uniform loading and applying Rayleigh's device.

An Integral-Equation Approach to Problems of Vibrating Beams. Walter T. White. *Franklin Institute, Journal*, Vol. 245, No. 1, January, 1948, pp. 25–36, diagrs.

A method of calculating the normal modes of vibrating beams in which both exact and approximate solutions of the integral equations are obtained. The Green's function, or kernel, of the equation is constructed for both uniform and nonuniform beams. Solutions are worked out for the uniform cantilever and the first and second modes of a nonuniform, naturally twisted, turbine blade.

Vibration-Free Mounting With Auxiliary Mass. J. A. Haringx. (*Philips Technical Review*, Vol. 9, No. 1, 1947, pp. 16–23.) *Engineers' Digest*, Vol. 4, No. 12, December, 1947, pp. 564–567, diagrs. 5 references.

Mechanical Vibration Recorder. Chester B. Cunningham. *Machine Design*, Vol. 20, No. 1, January, 1948, pp. 133, 134, illus.

A stylus that records on a moving strip of waxed paper is linked to a probe through an amplitude reducing linkage. Time reference is provided by another scriber acuated by the armature of a dry-cell energized timing magnet. The instrument was originally made by the Askana Werke, A.G., Berlin. An American model will be produced which will weigh 3.75 lbs.

About the Determination of the Unsteady Lift-Coefficients Necessary for Flutter Calculations in Wind-Tunnel Tests by Means of the Light-Interference Method. Arnold Ritter. *U.S., Air Force, Technical Report No. F-TR-1158-ND*, January, 1948. 12 pp., illus. 4 references.

Wind-tunnel measurements were made on model wing profiles. The optical-interference method was used in order to obtain reproducible data that could be evaluated with accuracy for the nonstationary coefficients and the reduced frequency at every pressure distribution for various angles of attack, flow velocities, and model frequencies.

Flutter Tests of Modified SBQU Model in 16-Foot Tunnel. Theodore Theodorsen, R. P. Coleman, and N. H. Smith. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-742)*, August, 1943. 45 pp., illus. 2 references.

How Processing Affects Bolt Fatigue Strength. N. B. Green. *Machine Design*, Vol. 19, No. 12, December, 1947, pp. 138–140, 142–146, illus.

Thermodynamics

The Kinetic Basis of Thermodynamics. M. Born and H. S. Green. *Royal Society of London, Proceedings, Series A*, Vol. 192, No. 1029, February 4, 1948, pp. 166–180. 17 references.

The thermodynamic properties of any system are deduced from quantum mechanics. The proof of a generalized H-theorem for two fundamental irreversible processes (the conversion of other forms of energy into heat and the flow of heat from one temperature to another) demonstrate that the entropy, correctly defined, must increase and the system must tend toward a state of equilibrium. A simple but rigorous proof of Boltzman's law permits the thermodynamics of reversible processes to be inferred. An exact solution of the most general time-dependent perturbation problem of quantum mechanics is included in an appendix.

Wind Tunnels and Laboratories

The Effects of Compressibility on the Two-Dimensional Subsonic Wind-Tunnel Constriction Correction. H. T. Epstein and L. U. Albers. *Journal of the Aeronautical Sciences*, Vol. 15, No. 3, March, 1948, pp. 144–150, figs. 8 references. (Cf. AER 11/47:18.)

An Introduction to Wind Tunnels and Their Problem. W. G. DeHart. *The Engineering Journal*, Vol. 30, No. 12, December, 1947, pp. 609, 610. 1 reference.

The use of wind tunnels and models to determine the aerodynamic characteristics of aircraft requires correction for the difference in turbulence, Reynolds Number, and Mach Number between the test and flight conditions. Recent attempts to overcome this difficulty have been made by the use of low-turbulence tunnels, variable-density and variable-speed tunnels, and the N.A.C.A. wing-flow method.

Supersonic Wind Tunnel Under Construction at Naval Ordnance Laboratory, White Oaks, Md.; Kochel Design. *Product Engineering*, Vol. 19, No. 2, February, 1948, p. 154, illus.

Britain's 600-m.p.h. Wind Tunnel. II. *The Aeroplane*, Vol. 74, No. 1912, January 30, 1948, pp. 135–137, illus.

Description of the R.A.E. installation, the balance mechanism, and the speed-measuring equipment. Reynolds Numbers up to 0.5×10^6 will be obtained with 1-ft. models.

High-Speed Research; The Design and Work of the Large Tunnel at Farnborough (R.A.E.) W. G. A. Perring and A. Thom. *Flight*, Vol. 53, No. 2037, January 8, 1948, pp. 34–37, illus. (Extended abstract of a paper.)

Water Turbos Power French Wind Tunnel. *Aviation Week*, Vol. 48, No. 3, January 19, 1948, pp. 27, 28.

Dual 49-ft. fans will produce an air speed of 0.925 Mach in the 46-ft. test section of the 1,280-ft. single-return closed-circuit tunnel. Provision will be made for testing jet engines of 10,000 equivalent horsepower.

Sonic Wall Tester. *Western Flying*, Vol. 28, No. 2, February, 1948, pp. 15, 16, illus.

Northrop Aircraft, Inc., has constructed at Muroc Air Base a rocket-powered sled running on a railroad track to propel aerodynamic models through the free atmosphere at supersonic speeds. Five Monsanto T10-E1 solid-fuel rockets, each developing 10,000 lbs. of thrust for 1.8 sec., move the test rig at speeds as high as 1,019 m.p.h.

Report From Eglin. Frank J. Delear. *The Bee-Hive*, Vol. 23, No. 1, January, 1948, pp. 28–31, illus. General summary of research projects at the Air Proving Ground Command, Eglin Field, Fla.

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Books

Research in Industry; Its Organization and Management. Edited by C. C. Furnas. New York, D. Van Nostrand Co., Inc., 1948. 574 pp., illus. $6.50.

This work presented under the auspices of the Industrial Research Institute, Inc., and edited by Dr. C. C. Furnas is a comprehensive study of the problems encountered in the prosecution of many phases of industrial research.

The points of view represented in the book come from a diversified range of interests exemplified by such industries as textiles, rubber, petroleum, food, domestic appliances, mining, electronics, explosives, aviation, and general chemistry.

As a preface to the purposes of the book, Dr. Furnas aptly quotes the objectives of Industrial Research, Inc.:

1. To promote, through the cooperative efforts of its members, improved, more economical, and more effective techniques of organization, administration, and operation of industrial research.

2. To develop and disseminate information as to the organization, administration, and operation of the industrial and social activity of the nation.

3. To stimulate and develop an understanding of research as a force in the economic, industrial, and social activity of the nation.

4. To promote high standards in the field of industrial research.

A good deal of attention is devoted to housekeeping problems in the research laboratory, such as budgeting, accounting, preparation of reports, organization charts, and planning of facilities and equipment.

Considerations entering into the selection of research projects, setting up the research program, fostering the research atmosphere, encouragement of personnel, professional development of the worker, and responsibilities of the research director are treated in a broad fashion.

A great deal of emphasis is placed on human relationships within the department and the creation of an environment that goes to make a happy family. Most of the authors stress the individual worker both as a person and as part of the team.

While some laboratories accept only problems lying within the competence of the staff, the larger organizations for the most part build up or bring in from the outside the personnel necessary for the research tasks selected for prosecution. There is, nevertheless, fairly general agreement that the success of the organization revolves in large measure about the personality of the individual research worker, and his aptitudes and preferences are given a great deal of consideration when he is selected for specific assignments. Valuable suggestions are given as to methods of helping the research worker develop his personality and further his professional development.

Considerable attention is given to the subject of patent policy, patents, licenses, patent pools, and royalties.

The relation of the laboratory to its surroundings is covered in chapters on public relations, relations with the educational system, and relations with other firms and industries. There is also a comparative evaluation of research in America and in Europe.

The book can be read with profit by anyone having a responsible connection with industry or government. I particularly commend it to individuals and organizations dealing with the investment of large sums of money in industrial enterprises.

FRANK W. CALDWELL
Director of Research
United Aircraft Corporation

For information on I.A.S. Library Service Facilities, see page 39

Principles of Jet Propulsion. M. J. Zucrow. New York, John Wiley & Sons, Inc., 1948. 563 pp., illus., diagrs. $6.50.

Professor Zucrow dedicated this book to his "beloved but much neglected wife." Fortunately, he has something to show for it.

The book is based on a lecture course given by the author for the University of California's ESMWT program in 1943 and 1944. Its main objective was "the presentation of requisite fundamental theory pertinent to an intelligent understanding of jet-propulsion engines and gas-turbine power plants." This objective has been reached successfully.

The titles of the 13 chapters are revealing in themselves. They are:

1. Review of Fundamental Principles. 2. Momentum and Energy Relationships for Fluids. 3. Thermodynamics of Gas Flow. 4. Thermodynamic Properties of Air. 5. Airplane Performance Calculations. 6. The Airplane Propeller. 7. The Gas Turbine Power Plant. 8. The Gas Turbine Type of Thermal Jet Engine. 9. Air Compressors. 10. Turbine Characteristics. 11. The Combustion Chamber. 12. The Rocket Motor. 13. Some Aspects of High Temperature Metallurgy.

Professor Zucrow endears himself, at least to some of his critical readers, by starting out his "Review of Fundamental Principles" with a discourse on dimensional analysis. The first chapters of his book cover many of the classic theories, conceptions, and data that form the background of jet propulsion and gas turbine work. Here one finds, for example, some of the thermodynamic properties of air, taken from Keenan and Keyes' tables. As one would hope for work on jet propulsion, a good deal of attention is paid to flow in ducts, with many of the relations expressed graphically.

It is to be expected, in a work of this kind, that in order to gain an insight into the fundamental relations, the author has to make simplifying assumptions. In fact, one of the chief values of "The Principles of Jet Propulsion" is the clearness with which the solutions of complex problems are presented. On the other hand, the reader must realize that, from a design standpoint, such solutions may be academic. When Professor Zucrow states "the turbines for turbojet engines have been mainly single-stage Rateau machines because of their lower weight" and proceeds to calculate wheel diameter and blade stress on the basis of constant cross-sectional area of the blade throughout its length, he is dealing with the subject in an abstract fashion. Thus, the student will somehow have to judge whether some of the formulas and examples given are applicable to actual design or whether they represent a drastic simplification in order to bring out the relation between underlying factors.

As Professor Zucrow states in the Preface, the book is not written for the specialist. While the designer will find the fundamental treatment useful, a book of this kind cannot possibly supply detail design informa-

tion on turbines, compressors, or combustors.

It is to be regretted that, as the lectures were prepared in wartime, the illustrations of actual jet-propulsion engines were largely collected from G. G. Smith's booklet, *Gas Turbines and Jet Propulsion* and from the then available patent literature. This has resulted in a somewhat musty atmosphere.

Progress in jet propulsion has been rapid, and it is hoped that in subsequent editions it will be possible to keep up to date with what has been achieved. This comment, of course, does not apply to the fundamental principles, which are ageless and which are dealt with in such a fashion as to make Professor Zucrow's book a useful addition to the literature.

R. P. KROON
Manager of Engineering
Aviation Gas Turbine Division
Westinghouse Electric Corporation

Frontiers of Flight. George W. Gray. New York, Alfred A. Knopf, 1948. 362 pp., figs. $6.00.

The National Advisory Committee for Aeronautics, created by Act of Congress March 3, 1915, has grown from a small beginning to a vast organization with three splendid laboratories at its command. Its history is the history of American aeronautical research, and its story has long deserved to be told. Now this story has been splendidly written by Mr. Gray, who has long and successfully specialized in the popular interpretation of science. *Frontiers of Flight* can be read by any layman with an intelligent interest in the growth of aeronautical science. At the same time it provides for engineers and other professionally interested men an accurate and stimulating account of research in their special fields. Mr. Gray tells interestingly what has been done, explains clearly, gives a synthesis of the whole, and indicates paths to future advances.

Chapter 1, "The National Advisory Committee for Aeronautics," and Chapter 2, "The Organization of Research," give a record of the Committee's growth and a brief account of its laboratories and organization, supported by a useful appendix, at the end of the book, of names and dates. Chapter 3, "Tunnels and Other Tools," well illustrated, conveys a vivid picture of what the tunnels look like and does not hesitate to deal with the Reynolds Number in semiprofessional style. "Air and Water" is a fine title for the next chapter which presents the elements of the seaplane in modern fashion. Chapter 5, "Speed," leads to an account of compressibility effects and the cone wave front which is unsurpassable in simplicity. Then we read in Chapter 6 an excellent account of flaps, low-drag wings, cowls, scoops, and clean-up tests, followed by an equally good chapter on "Stability and Control."

"Determining the Loads" covers pull-outs, gust loads, the gust tunnels, and structural research. "Structures to Carry the Load" (Chapter 9) could well be required reading for all students before they take up airplane stress analysis. There would be no excuse after reading "High Speed Propellers" for being ignorant of the advantages of dual rotation, of the high-speed blades suitable for propellers, and of the general history of the propeller art. "Heat into Horsepower" and "Engines to Turn Propellers" will give all aviation men who are not actually in power-plant work much useful information on supercharging, fuels, cooling fins, and compression ratios. Chapter 13, "Jet Propulsion," is the best short popular account we have seen of these modern power plants, the turbojet, turboprop, ram-jet, and athodyd. We like particularly the fine explanation of various methods of thrust augmentation, such as the employment of auxiliary combustion and auxiliary jet. "Heat Against Ice" covers work on ice prevention in power plant and wing in which the N.A.C.A. has distinguished itself in recent years. The last chapter, "Transonic and Supersonic," gives a fine introduction to the new shapes of airfoils, to low aspect ratio, to triangular wings and other manifestations of high Mach Numbers. There is a fine index. Aeronautical men will benefit by reading the book themselves and when their friends ask for explanations of recondite aerodynamic phenomena, their best defense will be to suggest the reading of Mr. Gray's fine book.

DR. ALEXANDER KLEMIN
Consulting Engineer
Greenwich, Conn.

Fluid Mechanics of Turbomachinery. George F. Wislicenus. New York, McGraw-Hill Book Co., Inc., 1947. 613 pp., diagrs. $7.50.

Modern fluid dynamics and its applications to the theory of compressors, turbines, propellers, and hydraulic couplings are presented by the author, a highly successful designer and research engineer, in systematic and comprehensive treatment. Emphasis is laid upon basic aspects, which are treated rigorously, yet without unnecessary mathematical detail. Selection of the material from the large amount of specialized literature has been made with a view to the needs of the engineer in practice. Its presentation is such that the book may serve also as a text for the advanced student of engineering.

A distinct contribution is the emphasis given to similarity considerations, which are regarded as equal in importance, not subsidiary, to the fluid dynamic theory of turbomachines. Certain concepts in common use in hydraulic turbine and pump engineering have been extended in such a way that they may be applied as criteria of operation to machinery for compressible fluids.

Because of the stress laid upon fundamental relationships of fluid flow, those features of operation which are common to the various types of turbomachines are brought out. Thus the book represents a significant contribution to the trend toward integration of methods of engineering treatment of performance and design problems in the various branches of turbine, compressor, and pump engineering.

Wherever possible, preference has been given to procedures of theoretical treatment of fluid flow problems readily applicable in engineering work, discernible by the emphasis laid upon methods based upon one-dimensional fluid flow theory. However, the two-dimensional theory has also found extensive treatment, both for incompressible and for compressible flow. Significant methods of two-dimensional theory for axial as well as for radial flow are reviewed with emphasis upon their physical significance while the underlying mathematical work is alluded to by references to specialized literature.

Special aspects pertaining to hydraulic machinery are presented by a comprehensive treatment of cavitation phenomena and their significance in design and operation. Flow problems of gas and steam turbines receive attention in the chapters dealing with phenomena of compressible flow, including also thermodynamic problems of high velocity flow. The sys-

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tematic presentation of methods of engineering calculations of supersonic flow, including the method of characteristics and the hodograph method, appears to anticipate future developments in compressor design practice, in particular.

The treatment of certain fields of the fluid dynamic theory of turbomachines not as yet readily amenable to mathematical methods of analysis, such as problems of three-dimensional flow and of flow with friction, betrays the author's wide experience in the fields of research and of design. In contrast to these elusive problems, the last chapter, dealing with various geometrical procedures arising in the design of turbomachines, stresses an important practical aspect of turbomachine engineering.

Repeatedly, engineering developments are traced to most recent advances in the theory of fluid dynamics and its application to turbomachines, thereby illustrating the significant fact that this field of the engineering sciences is at present experiencing a period of intense and rapid development.

PROF. JOHN R. WESKE
Ohio State University

A Chronicle of the Aviation Industry in America, 1903–1947; a Salute to the Aviation Industry. Cleveland, Eaton Manufacturing Co., 1948. 98 pp., illus.

This chronicle is a source book of great value. It records about 3,000 facts and events year by year, nearly 2,000 of which are in the main chronology according to specific dates.

After 1918, company activities are included separately for each year, alphabetically by companies, and over 1,000 supplementary items are recorded in this way. Flying events and records, appointments and awards, production and technical development, and the activities of Congress, the military and naval services, and Government civil agencies for research and administration are thus collected from widely scattered sources in convenient and usable form. The heavier-than-air field is covered predominantly, but outstanding lighter-than-air developments will be found as part of the record, along with developments in such fields as meteorology, ice prevention, instrument flying, power plants, air mail and air transport, and rotary wing aircraft. Special mention should be made of the photographs. There are more than 250 of them, usually two or more to a page, and they are exceptionally clear, with informative captions. The layout of pages, as well as the content of the chronology, shows careful workmanship.

An index of names, places, airplanes, equipment, and organizations would add to the usefulness of the volume, but it would be

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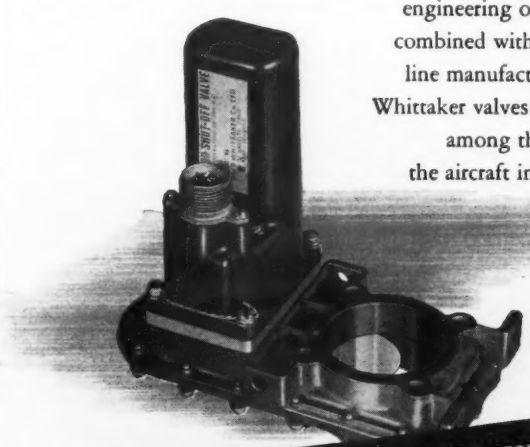
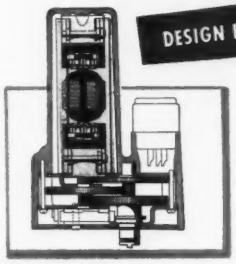
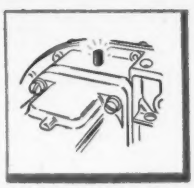


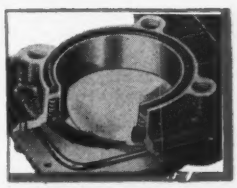
DESIGN FEATURES OF WHITTAKER MOTOR-OPERATED VALVES



POWER PACK – Demountable power pack adaptable to 6, 12 or 24 volt systems. Dynamic braking of motor locks valve in position. Operating times of 1 to 60 seconds. Conforms fully to AN-M-10a specifications.



VISUAL INDICATOR – Spring loaded pin, actuated by valve drive shaft, indicates valve gate position. Ground crew can immediately determine position of shut-off valve.



FLUID SEAL – Highly polished sliding gate operates between two spring-loaded, aromatic resistant sealing rings. Fluid pressure assures perfect no-leak sealing. Complete valve has winterization yellow dot approval.

Individually-engineered designs...easier installation...better operation...lower maintenance! These are the benefits you get with Whittaker's specialized aircraft valves. Let Whittaker engineer proven-valve designs to meet your specific requirements. WM. R. WHITTAKER CO., LTD., 915 N. Citrus Ave., Los Angeles 38, California. Eastern representatives – AERO ENGINEERING INC., Roosevelt Field, Mineola, New York.

Whittaker

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LEVER AND MOTOR-OPERATED SLIDING GATE SHUT-OFF VALVES • DRAIN COCKS • PLUG VALVES • 3-WAY PLUG VALVES • 4-WAY SELECTOR PLUG VALVES • SWING CHECK VALVES • HYDRAULIC CHECK VALVES

a considerable job in itself to compile such an index from more than 75,000 words of factual data. The chronicle as it stands is a contribution to the history of American aeronautics. It serves a purpose which previously was not filled by any single chronology, and the Eaton Manufacturing Company should be congratulated on its production.

Other Books Received

AERODYNAMICS

FLUID MECHANICS & AERODYNAMIC THEORY

Hydraulics. Horace W. King, Chester O. Wisler, and James G. Woodburn. 5th Ed. New York, John Wiley & Sons, Inc., 1948. 351 pp., diagrs. $4.00. In this edition of a textbook of elementary hydraulics, last revised in 1941, new text material has been added on the variation of hydrostatic pressure with altitude in a compressible fluid, on the flow through gates and over dams, on the flow of liquids in pipes, on the analysis of flow in pipe networks, and on the resistance offered to motion of objects through a fluid. A chapter on hydraulic similitude and dimensional analysis has been added, and new problems are included in most chapters. Professors King and Wisler are at the University of Michigan, and Professor Woodburn is at the University of Wisconsin.

AIRPLANE DESIGN & DESCRIPTIONS

Airworthiness Directive Summary, January 1, 1948. Washington, U.S. Civil Aeronautics Administration, 1948. 62 pp. A complete summary superseding airworthiness directives effective on December 31, 1947, which have been issued within the previous 5 years.

AIRPORTS & AIRWAYS

National Airport Plan for 1948. Washington, U.S. Civil Aeronautics Administration, 1948. 192 pp., maps, diagrs. Lists and state summaries are given of public airports, development or improvement of which is considered necessary to accommodate the anticipated volume and flow of air traffic within the next 3 years. General planning data on population, area, certificated air routes and stops, registered aircraft, and airports are included for each state, and the estimated cost of various classes of airports, seaports, and heliports to sponsors and the Federal Government. Supplementary data covering the country as a whole are given in appendixes.

ATOMIC ENERGY

The Science and Engineering of Nuclear Power. Ed. by Clark Goodman. Cambridge, Mass., Addison-Wesley Press, Inc., 1947. 539 pp., diagrs. $7.50. The fundamentals of chain reacting systems are presented for the nonspecialist, particularly for the engineer interested in the industrial applications of nuclear energy. The book grew out of a series of seminars begun at the Massachusetts Institute of Technology in 1946. Contents: Fundamentals of Nuclear Physics, by Robley D. Evans; The Fission Process, by Martin Deutsch; Neutron Diffusion, by Victor F. Weisskopf; Nuclear Chain Reactions, by E. P. Wigner; Elementary Pile Theory, by F. L. Friedman; The Application and Experimental Basis of Pile Theory, by Bernard T. Feld; Chemistry of the Fission Process, by Charles D. Coryell; Control and Operation of a Pile, by W. J. Ozeroff; Construction of Nuclear Reactors, by Clark Goodman; Heat Transfer, by E. R. Gilliland; Heavy Elements and Nuclear Fuels, by John W. Irvine, Jr. A table of precise masses, formulas for the calculation of the loss of energy in elastic collisions, and a compilation of curves of neutron cross sections of the elements are included in appendixes.

ELECTRONICS

Summary Report of Electronic Aids to Air Navigation. U.S., Air Force, Air Materiel Command. Wright Field, Dayton, Ohio, 1947. 96 pp. Synopses are presented of six short-distance navigational systems, five long-distance systems, three heading and homing systems, seven approach-control systems, and seven integrated systems. Summaries are presented also of equipment for weather detection by radiosonde and ground radar, traffic control, airborne obstacle and weather detection, and absolute altimeters. Emergency rescue aids and air-borne radio communications equipment are also described. A glossary is included.

Klystron Tubes. A. E. Harrison. New York, McGraw-Hill Book Co., Inc., 1947. 271 pp., illus., diagrs. $3.50. This is designed as a theoretical text on the principles of "velocity modulation," which has resulted in an extension of the radio-frequency spectrum to the super-high-frequency region above 1,000 Mc. This method of controlling an electron beam, which varies the velocity of the electrons in a beam of constant density without dependence on varying the emission from a cathode, is the basic principle of klystron tubes. The reader needs an understanding of electronics and the fundamentals of radio, but the introductory chapters assume no knowledge of the principles of klystron tubes. Mathematical derivations have been simplified, and practical interpretations of the theoretical equations are given. The last third of the book takes up klystron operation, power supplies, and microwave techniques. A glossary of terms and symbols, 13 design charts, and a bibliography of about 100 articles and books are included in appendixes. The author is a professor of electrical engineering at Princeton University and was formerly a klystron applications engineer with the Sperry Gyroscope Company.

R.C.A. Technical Papers Index. Vol. I (1919–1945), Vol. II (a) (1946). Princeton, N.J., Radio Corporation of America, R.C.A. Laboratories Division, 1947. 2 Vols. 143, 21 pp. About 1,980 papers of RCA authors on 18 subjects in radio, electronics, and related fields are listed chronologically, then alphabetically by titles, with author and subject indexes.

Television: A Bibliography of Technical Papers by R.C.A. Authors, 1929–1946. Princeton, N.J., Radio Corporation of America, R.C.A. Laboratories Division, 1946. 10 pp. A chronological list of 275 technical papers on television and related subjects, published in about 30 American and British periodicals.

ENGINEERING PRACTICES & AIDS

Technical Drawing Problems. Frederick E. Giesecke, Alva Mitchell, and Henry Cecil Spencer. 2nd Ed. New York, The Macmillan Co., 1947. 105 pp., diagrs. $2.75. These problems can be used with any good textbook but were prepared especially for use with the authors' *Technical Drawing* (2nd Ed., 1940). They are not designed as a complete course in themselves. The arrangement is in 21 units, ranging from the use of instruments and the geometry of technical drawing through vertical and inclined letters and numerals and missing line and missing view problems to dimensioning, fasteners, and springs.

Standard Welding Symbols and Rules for Their Use. Prepared by A.W.S. (American Welding Society) Committee on Symbols. New York, American Welding Society, 1947. 67 pp., diagrs. $0.50. Basic symbols for arc and gas welding, resistance welding, brazing, forge, thermit, induction, and flow welding, and for basic types of joints and welds, are given in the first two sections, followed by a useful section of general provisions for location of symbols, use of combined symbols and of various symbols applicable to all types of welds. Symbols and rules for fillet, groove, bead, plug, slot, spot, seam, projection, flash and upset welds are given in the remaining nine sections.

FUELS & LUBRICANTS

A.S.T.M. Standards on Petroleum Products and Lubricants (With Related Information); Methods of Testing, Specifications, Definitions, Charts and Tables. Philadelphia, American Society for Testing Materials, October, 1947. 690 pp., diagrs. $4.75. Standards and tentative standards on motor and aviation fuels, Diesel and burner fuels, kerosene and illuminating oils, lubricating oils, greases, petrolatums, paraffin waxes, electrical insulating oils, hydrocarbon solvents, and other petroleum products are brought together in convenient reference form.

LAWS & REGULATIONS

The Patent Application, Preparation and Prosecution. B. P. Fishburne. 2nd Ed. Washington, John Byrne & Co., 1947. 239 pp., diagrs. $7.50. The chapter on the patent application takes up 73 pages and is a detailed exposition fulfilling a primary purpose of the book. Introductory material on United States patents precedes this chapter, and the remaining two-thirds of the book deal with procedures in the execution and filing of the patent and succeeding steps, the essentials of patent law as practiced, and suggestions for preparation for the examination for registration before the U.S. Patent Office. Recommendations are made for more specialized works to be studied, but the principal aim of this book to provide an elementary work for use by beginners or students, which may also be of use to experienced patent attorneys, has been achieved

MATERIALS

Aluminum and Its Applications. Hiram Brown, with the collaboration of Alexander Klemin (and others). New York, Pitman Publishing Corp., 1948. 338 pp., illus. $5.75. The first half of this book deals with the properties, fabrication, finishing, and heat-treating of aluminum alloys. A chapter is included on testing methods and definitions of terms. Applications of aluminum in various industries are discussed in the second half of the book, including Aviation, by S. H. Phillips; Aircraft Engines, by Melvin H. Young; and Aluminum Castings for Aircraft, by Norman E. Woldman. Aluminum in the automotive, railroad, marine, electrical, and chemical industries is also discussed by specialists. A summarizing chapter on Aluminum, Present and Future, is contributed by Arthur A. Schwartz. Tables of mechanical properties, composition, and test results are given in 28 appendixes.

Plastics Dictionary. Thomas A. Dickinson. New York, Pitman Publishing Corporation, 1948. 312 pp., illus., diagrs. $5.00. This useful dictionary contains definitions of about 4,000 terms used in the plastics industry. About 1,500 of these are trade names of American and some foreign companies. The molecular structures of such substances as resorcin-aldehyde resins, polyisobutene, shellac, and Styramic materials are shown, and such terms as platen, plywood molding, and temperature test are illustrated with drawings. Tables of catalysts, fillers, pigments (11 pages), plasticizers (12 pages), and solvents (18 pages), as well as tables of chemical elements and temperature conversion, are included, and there is a bibliography of about 80 books and 16 periodicals consulted. The unusually thorough cross-indexing to related terms adds to the use-

Experts said it couldn't be done!

● The history of aviation is the history of engineers doing the impossible.

Not so many years ago, experts claimed that an airplane supported by propeller blades alone was an impossibility. Yet here is the Sikorsky S-51 Helicopter opening up new possibilities in rescue missions on sea and on land, carrying mail to congested cities, dropping into and rising from spots hardly larger than the diameter of its swinging rotors.

The transmission that drives the rotor of this revolutionary craft is produced by Foote Bros. Gear and Machine Corporation.

Incorporated in this transmission are "A-Q" (aircraft quality) Gears that have brought to industry a new conception of gearing performance. Light in weight —compact in size—low in noise level—they permit carrying excessive loads at extremely high speeds.

Foote Bros. "A-Q" Gears may offer your engineers a solution to a difficult problem they face.

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This complete packaged drive is produced for the Sikorsky S-51 by Foote Bros. It is a self-contained, self-lubricated double planetary transmission with angle take-off. Spur and spiral bevel gears are "A-Q" (aircraft quality).

FOOTE BROS.

Better Power Transmission Through Better Gears

AIRviews

Opening up before us—air carriers and aircraft manufacturers alike—is a great revenue potential that has been slow in developing.

I'm speaking, of course, of the future in air cargo, as contrasted with passenger revenue. Only since the war have the vast opportunities in this field been approached realistically. There is still a long way to go.

Even today, for example, 95% of the revenue of all U. S. air transportation companies comes from carrying passengers; only 5% from freight. Contrast this with rail transportation, which gets 18% of its total revenue from passengers and 82% from freight!

Naturally, the flying of passengers will always remain a vital and glamorous part of our aviation picture. But there is reason to believe that the flying of cargo offers far more dollars and cents return.

What seems called for now is more careful over-all planning toward the successful handling of air cargo, and a long-range program for selling this service to management.

Cargo compartments of passenger planes and converted passenger planes must be replaced with aircraft specifically designed to handle cargo. Standard methods of tying down and loading and unloading must be devised. And fair rates established on a competitive basis.

In meeting and solving these problems, we here at Douglas stand ready to aid the air carriers in every possible way.

Donald W. Douglas

PRESIDENT
DOUGLAS AIRCRAFT COMPANY, INC.
SANTA MONICA, CALIFORNIA

fulness of the book. Many definitions of materials include physical properties and industrial applications, or, as in the case of vermiculite, the chemical composition. This dictionary can be recommended as a well planned and executed reference book of plastics terms.

NAVIGATION

Applied D.R. Navigation and Flight Planning; a Practical Introduction to Air-Line Navigation. J. H. Clough-Smith. London, Sir Isaac Pitman & Sons, Ltd., 1947. 241 pp., diagrs. 22*s.* 6*d.* The author's *Applied D.R. Navigation* (1943) comprises the first part of this book. Flight planning is taken up in the second part, including chapters on the critical point and fuel-consumption curves. Air-line navigation is covered in the third part and sample examination papers and problems in the final part. Miscellaneous methods of wind finding, positions and pinpoints, and extracts from the Q Code are given in appendixes. The book is planned for practical use in air-line navigation and for those wishing to take examinations as set by the Ministry of Civil Aviation for 1st Class and 2nd Class Navigator ratings.

Terrain Flying; Presenting Advice of Veteran Pilots to Promote Safety. U.S. Civil Aeronautics Administration. Washington, U.S. Govt. Printing Office, 1947. 28 pp., illus. $0.25. The experience of a large number of pilots in flying over specific areas in North America and various types of terrain is condensed into a convenient manual for beginning pilots and those planning flights over strange territory.

OPERATIONS

COMMERCIAL

International Civil Aviation Organization. Special Committee on Temperature Accountability. Final Report on the Paris Meeting (September–October 1947). (Document 4643.) Montreal, International Civil Aviation Organization, 1947. 84 pp., map. $0.75. These reports of Committee actions and recommendations include tentative definitions of air temperature, proposals for rules of temperature accountability for take-off and take-off climb, en route and landing, and discussion of atmospheric conditions on power and methods of assessing changes of engine power with changes in atmospheric conditions.

Bibliography on Aviation and Economic Entomology, compiled by Ina L. Hawes and Rose Eisenberg. (U.S. Department of Agriculture, Bibliographical Bulletin No. 8.) Washington, U.S. Govt. Printing Office, 1947. 186 pp. $0.35. The period covered is 1919–1944, with over 50 references published in 1945. A total of 1,084 annotated references is listed chronologically, with a detailed index of authors, airplanes, operations, place names, plants, insects, and materials.

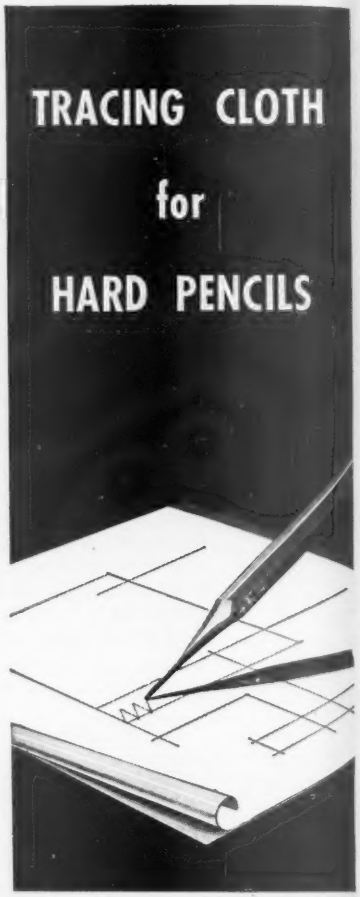
PERSONAL FLYING

Facts of Flight, Practical Information About Operation of Private Aircraft. George Sidney Stanton. U.S. Civil Aeronautics Administration. Washington, U.S. Govt. Printing Office, 1947. 41 pp., figs. $0.50. A brief manual on atmospheric pressure and lift, angle of attack, stalls and spins, airplane structure, engines, flying the plane, airport traffic, seaplanes, and safety in flight, written in nontechnical language.

POWER PLANTS

JET & TURBINE

The Modern Gas Turbine, Its Uses as an Exhaust Turbosupercharger or Prime Mover in All Fields of Service, Including Jet Propulsion. R. Tom Sawyer. 2nd Ed. New York, Prentice-Hall, Inc., 1947. 224 pp., illus., diagrs. $4.00. In this new edition of a book first published in 1945, new material has been added in the chapter on turbosuperchargers for aircraft engines. The chapter on the gas turbine as an aircraft prime mover, including jet propulsion,



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has been completely rewritten by S. T. Robinson and K. A. Browne. Questions for review have been added in an appendix.

POWER PLANTS

ROCKET

Rocketry, Jets and Rockets; the Science of the Reaction Motor and Its Practical Application for Aircraft and Space Travel. Constantin Paul Lent. New York, Pen-Ink Publishing Co., 1947. 254 pp., illus., diagrs. $5.00. Following a review of past and future developments, the principles of the rocket and its motor and of the thermal-jet motor are outlined. Chapters on rocket flying and thermal-jet flying are included. Succeeding chapters deal with the possibilities of interplanetary navigation, interstellar rocketways, the war rocket and its future, and the atom, the rocket, and the United Nations. The chapter on the "Rocketor's Workshop" contains practical information on testing, fuels, materials, and design calculations. Lists of U.S. and British patents and a list of rocket societies are included in appendixes. The book is illustrated with numerous excellent drawings and photographs

REFERENCE & BIBLIOGRAPHY

Lists of Reports Published by the Nationaal Luchtvaartlaboratorium (National Aeronautical Research Institute). Amsterdam, Nationaal Luchtvaartlaboratorium, 1947. 13 pp. All reports of the aerodynamics, flutter, materials, structures and flight sections of the Nationaal Luchtvaartlaboratorium and its predecessor body, the Rijksstudiedienst voor de Luchtvaart, which have been released for publication, are listed. A list of 12 volumes of the *Verslagen en Verhandelingen*, which appeared from 1921 to 1943, indicating 91 of the original 200 reports which were reprinted in them, is included. Prices of reports and volumes are given if they are available for sale. Most reports are in Dutch, but titles are given in English, and English is planned for increasing use in writing reports beginning in 1944.

RESEARCH

Geographical Distribution of Engineering Research and Related Industries in the United States. H. McKinley Conway, Jr. Atlanta, Ga., 5009 Peachtree Road, Southeastern Research Institute, Inc., 1948. 74 pp. $5.00. An analysis is presented of the sectional distribution of industrial research laboratories, universities engaged in research, authors of technical books, engineers listed in *Who's Who in America*, and research and manufacturing activity in the field of aircraft and accessories, and ten other selected industries. The conclusions are that research must precede industry; Northeastern and North Central states dominate the mobile industries at present because they lead in scientific research activity, but increasing research activity in Southeastern and Far Western areas indicates increased industrial activity there in the future for the eleven industries studied; development of industry in lagging areas can be accelerated by improving educational facilities, stimulating research support among business and Government leaders, establishment of small privately financed research units as well as larger units, more uniform distribution of federal research support and careful selection of research programs for maximum results. Competition in research activity is stressed as essential. A bibliography of 34 books and articles is included.

SCIENCES, GENERAL

CHEMISTRY

Surface Chemistry for Industrial Research. J. J. Bikerman. New York, Academic Press, Inc., 1947. 464 pp. $8.00. This book is designed for the industrial research worker who is familiar with plant procedures and aims to present the fundamentals of "surface science," with industrial applications where they have appeared in the literature. It is pointed out that instances of scientific investigation of industrial processes are still relatively few in the literature. The first chapter takes up liquid-gas relations, including surface tension, surface viscosity, foam prevention, and dissipation of fogs. The chapter on liquid-liquid relations takes up interfacial tension and emulsions. Chapter 3, on solid-gas relations, includes surface roughness, absorption, corrosion by gases, and problems of dust and smoke. Chapters on solid-liquid relations, solid-liquid-gas, and solid-liquid-liquid relations, and electric surface phenomena conclude the book. Over 1,000 bibliographical references are given at the ends of chapters. An author index and a subject index are provided.

Physical Constants of Hydrocarbons. Vol. IV. Polynuclear Aromatic Hydrocarbons. Gustav Egloff. New York, Reinhold Publishing Corp., 1947. 540 pp., diagrs., $17.50. Volume IV of this monumental compilation gives the available melting points, boiling points, density, and refractive indexes of more than 2,000 polynuclear aromatic hydrocarbons in 95 groups. The volume includes about 3,600 bibliographical references published up to April, 1945.

MATHEMATICS

Nomography. A. S. Levers. New York, John Wiley & Sons, 1948. 176 pp., diagrs. $3.00. A working knowledge is presented of the theory and design of nomographs, with special emphasis on the geometric method used in the development of the theory when equations of three or more variables are used. A final chapter deals with the use of determinants in the construction of alignment charts. A bibliography of 18 items is included, and an appendix of 29 alignment charts for determining bending moments, solving for density of fluid in a pitot tube traverse, solving the pitot tube formula for compressible fluids, determining engine r.p.m., and other applications in engineering, production, and statistics. The author is a professor of mechanical engineering at the University of California.

Calculus and Its Applications. Raymond D. Douglass and Samuel D. Zeldin. New York, Prentice-Hall, Inc., 1947. 568 pp. $5.15. This textbook is designed to cover the material essential for students of engineering and science in a shorter period of time than is usual in most schools and colleges and aims to enable the student to use the calculus early in his work. Long discussions are avoided when possible, and numerous examples are worked out to illustrate various applications of the principles. Exercises are given for most articles within chapters and review exercises at the ends of chapters. Chapters on ordinary differential equations and vectors have been included. The authors are professors at the Massachusetts Institute of Technology.

PHYSICS

Scattering and Radiation from Circular Cylinders and Spheres. Tables of Amplitudes and Phase Angles. A. N. Lowan and P. M. Morse, H. Feshbach, and M. Lax. Washington, U.S. Navy Department, Office of Research and Inventions, July, 1946. 124 pp. These tables were prepared under the direction of the Applied Mathematics Panel, National Defense Research Committee, for the Underwater Sound Laboratory of the Massachusetts Institute of Technology, for the use of physicists and engineers engaged in acoustical and electromagnetic wave research.

Catalogue of the Adolph Lomb Optical Library at the University of Virginia. With an introduction by James P. C. Southall. (University of Virginia Bibliographical Series No. 7.) Charlottesville, Va., Alderman Library, 1947. 203 pp. An alphabetical author catalog of about 3,000 books, periodical sets, reprints, extracts, pamphlets, and trade literature on optics.

Feature Articles Coming in the June Review

"Service Experience with Turbojets" by J. W. Bailey, Allison Division, General Motors Corporation

"Research Toward Greater Seating Comfort" by K. D. Jackman, Consolidated Vultee Aircraft Corporation

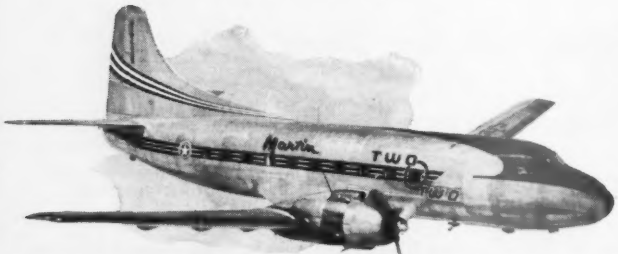
"The Prediction of Load Distribution and Its Effect on Aerodynamic Characteristics at Subsonic Speeds for Wings of Arbitrary Plan Form" by Victor I. Stevens, Ames Aeronautical Laboratory, N.A.C.A.

The case of airline Y*

Makes Good Reading for Cost-Conscious Executives Concerned With the Problems of Tomorrow

A Day's Earnings of *more than 3 times as much with one Martin 2-0-2* . . . as compared to possible earnings in the same period with a *prewar twin-engine plane!* Yet the much faster 2-0-2's cost of operation per airplane mile is very little, if any, more than the prewar ship while carrying twice the payload!

That's a Typical Example of why Airline Y is enthusiastic about the *new Martin 2-0-2*. And why this modern luxury liner spells profitable operation for airlines everywhere.



For Full Details on the new Martin 2-0-2 . . . and the outstanding performance which has made it *the world's top twin-engine airliner* . . . write today to: The Glenn L. Martin Company, Baltimore 3, Md.

Additional Facts . . . Airline Y, a South American line, flew one Martin 2-0-2 *over the Andes 74 times* in less than four months of operation. The present schedule calls for flights of approximately 3150 and 1600 miles on alternate days . . . with a full payload; *36 passengers on the 2-0-2* as compared to *21 passengers on a prewar plane*. Average use on the 2-0-2 has been about eight hours a day . . . a remarkable record since this airline does no night flying and seldom flies on Sunday. The Martin 2-0-2 has been crossing the Andes *when no other airplane could get across* . . . flying at 26,000 feet, over the top of the highest peaks and bad weather in the passes.

Martin
AIRCRAFT
Builders of Dependable Aircraft Since 1909

* Did you miss "The Case of Airline X"? We'll be happy to send you a copy.

Sections and Student Branches

(*Continued from page 13*)

publication, highlighted the meeting. Vice-Chairman A. W. Hindenlang, Editor of the paper, discussed the nature, purpose, and scope of the publication. Chairman Russell J. Cornair presided.

University of Florida

Election of new officers took place at the February 17 meeting as follows: Chairman, Ben Pasteur; Vice-Chairman, W. W. Petynia; Recording Secretary, Thomas Bell; Corresponding Secretary, Clyde Hayes; Treasurer, Alton G. Mitchell. Honorary Chairman is Prof. R. A. Thompson.

On March 2, Chairman Pasteur appointed W. F. Woodward and H. F. Weisenburger as representatives to the Benton Engineering Council.

Plans for the proposed trip to Eglin Field were discussed, and a committee was appointed to select the best date and make transportation arrangements for the trip.

Robert H. Bennett spoke on "Power Plants for Light Aircraft."

Georgia School of Technology

Twelve new members were enrolled at the February 25 meeting, Chairman Edmund E. Novotny presiding. Louis C. Setter reported on progress in the construction of a free-spin tunnel for the Engineers Day Display scheduled for April 17.

Gordon McHenry presented a film from Republic Aviation on *P-47 Aerobatics*.

University of Illinois

A short "get-acquainted" meeting was held March 3 and two films were shown: *Airliner* and *Jap Zero*. Chairman Edward J. Brisick presided.

Indiana Technical College

Officers elected at the February 18 meeting included: Chairman, Edwin J. Davis; Vice-Chairman, Eugene Colditz; Secretary, Manuel Costa; Treasurer, Edward Bonaccorsi.

Louisiana State University

A business meeting was held February 17 with Chairman Arthur W. Cruikshank, Jr., presiding.

Vice-Chairman Robert C. Matteson presided at the March 4 meeting during which a film on *The Construction and Development of the Bell P-59* was shown.

University of Minnesota

On February 4 the third meeting of the Student Branch was held at which the chief speaker was Dr. Newman A. Hall. Previously with United Aircraft Corporation, Dr. Hall spoke on his experiences in the aviation field, future problems of the industry, and methods in use to solve them.

Professor Ralph H. Upson gave a short report on the Institute's Sixteenth Annual Meeting in New York, following which a business meeting was held. Chairman Louis F. Heilig appointed a committee to prepare for the Annual Spring Banquet.

University of Notre Dame

Shell Oil Company's film, *Flight Log*, highlighted the February 26 meeting. It depicted the development of 100-octane fuel and the role it played in aircraft and engine design. Chairman Walter M. Marut presided.

At the March 11 meeting a Navy film, *G and You*, concerning the effects of gravity on pilots, was shown.

Ohio State University

Chairman John J. Scheider opened the meeting January 10 at which the principal speaker was Dr. Bernhard Goethert. Dr. Goethert, who is prominent in the field of theoretical aerodynamics and who is at present associated with the aerodynamics section at Wright Field, was head of German Flight Research, dealing with high-speed aerodynamics.

University of Oklahoma

A joint meeting was held February 17 with Tau Omega honorary society, during which the films *The Magic Carpet* and *Report on Jet Propulsion* were shown. Owen G. Morris, Vice-Chairman, presided..

Parks College of Aeronautical Technology

Two amendments to the Branch's constitution were made at the February 19 meeting.

William Scholl followed the business session with a paper on "The Combination Gas Turbine and Propeller." In it he compared the three power plants: reciprocating, prop-jet, and jet engines.

New officers were elected at the March 11 meeting as follows: Chairman, Richard Dean; Vice-Chairman, Milton Sheppard; Treasurer, Charles Beckman; Recording Secretary, Robert Hazlett; and Corresponding Secretary, Eugene Veras.

The Pennsylvania State College

The February 26 meeting was opened by Prof. S. K. Hoffman, Faculty Adviser, who welcomed newcomers to the campus. Joseph Eisenhuth, Vice-Chairman, introduced the subject of the two awards offered annually by the Institute: the Student Branch Scholastic Award and the Student Branch Lecture Award. He urged members to begin working for them.

A talk, "Production Engineering," was given by E. N. Baldwin, head of Production Engineering Department, a Westinghouse institution on the campus.

Purdue University

Chairman George Campbell at the February 17 meeting appointed four student committees as follows: Program—L. Bettis, B. Wiard, S. Burgess, and J. Marshall; Banquet—W. Roth, R. W. Lehman, and J. Marshall; Membership—R. Goff, R. Chute, and W. Place; Aeronautical Engineering Field Trip—E. Bracke, B. Wiard, H. G. McComb, and R. Breeder.

There were short talks by Harvey Hansberry and Lyle Tarbell, Power Plant Section, C.A.A. Experimental Station, Indianapolis. Their subject was "Aircraft Fire Protection."

In addition, films on aircraft fire protection tests were shown.

Renssaeler Polytechnic Institute

At the first two meetings of the spring semester, members heard talks on the Sixteenth Annual Meeting of the Institute in New York and a paper on "Problems in the Design of High Speed Aircraft."

Professor Andrew J. Fairbanks, of the Aeronautical Engineering Department, and Assistant Prof. Raymond E. Bolz discussed the entire 4 days of the meeting at the February 12 meeting. Preceding their talks a film, *The Power House of Aviation*, which depicted various stages of engine manufacture, was shown.

The following meeting, February 26, Allan I. Sibila, Assistant Chief Aerodynamicist of Chance Vought Aircraft's Aeronautical Design Section, who is a graduate of R.P.I., spoke on problems encountered in high-speed aircraft.

Stanford University

Principal speaker at the February 10 meeting was H. J. Allen, Chief, Division of High Speed Research, C.A.A. Ames Laboratory, who dis-

cussed "Current Aeronautical Research in Great Britain."

The speaker presented an informal résumé of his experiences and observations made during the joint I.A.S.-R.Ae.S. meeting in London last September. He described the difficulties encountered by the British because of limited equipment available for high-speed aeronautical research and the many gas turbine developments he had seen.

New officers elected at the meeting were: Chairman, Arthur S. Benson; Secretary-Treasurer, Charles R. Garbett. Permanent Program Committee consists of G. E. Cooper, R. D. Hayes, and J. F. Brahtz.

Texas A. & M. College

Members elected new officers at the Student Branch's February 10 meeting; these included: Chairman, M. D. Bennett; Vice-Chairman, M. S. Maltz; Secretary, Wayne H. Burch, and Treasurer, Robert C. Zivney.

An interesting talk on "Importance of Lightplanes in the National Defense Effort," was given by Eugene W. Norris, Vice-President, Engineering, Luscombe Airplane Corporation.

University of Toronto

Members heard J. C. Floyd, Assistant Engineer, A. V. Roe Canada Limited, on the subject, "Development Problems of a Jet Prototype Aircraft," at the February 18 meeting. C. F. Matthews, Chairman, presided.

Four aspects of the design and development of a jet transport were discussed: safety, speed, economy, and passenger and crew comfort. The speaker showed how safety factors and duplication of services specified by government regulations reduced the ratio of pay load to gross weight. It was pointed out that the designer must make use of all improvements in materials and structural design while still considering the costs involved in fabrication.

It was shown that while the cost per hour of flying time for jet aircraft is higher than for the conventional powered plane, the cost per mile for the jet was less because of its greater speed and reduced flight time. Since jet engines are most economical at high altitude, pressurized cabins for passengers and crew must be incorporated to permit rapid climbs and descents. This factor imposes difficult design problems, particularly around doors and windows, Floyd said.

In Canada, extremes of temperature and humidity create other problems with jet engines, such as de-icing

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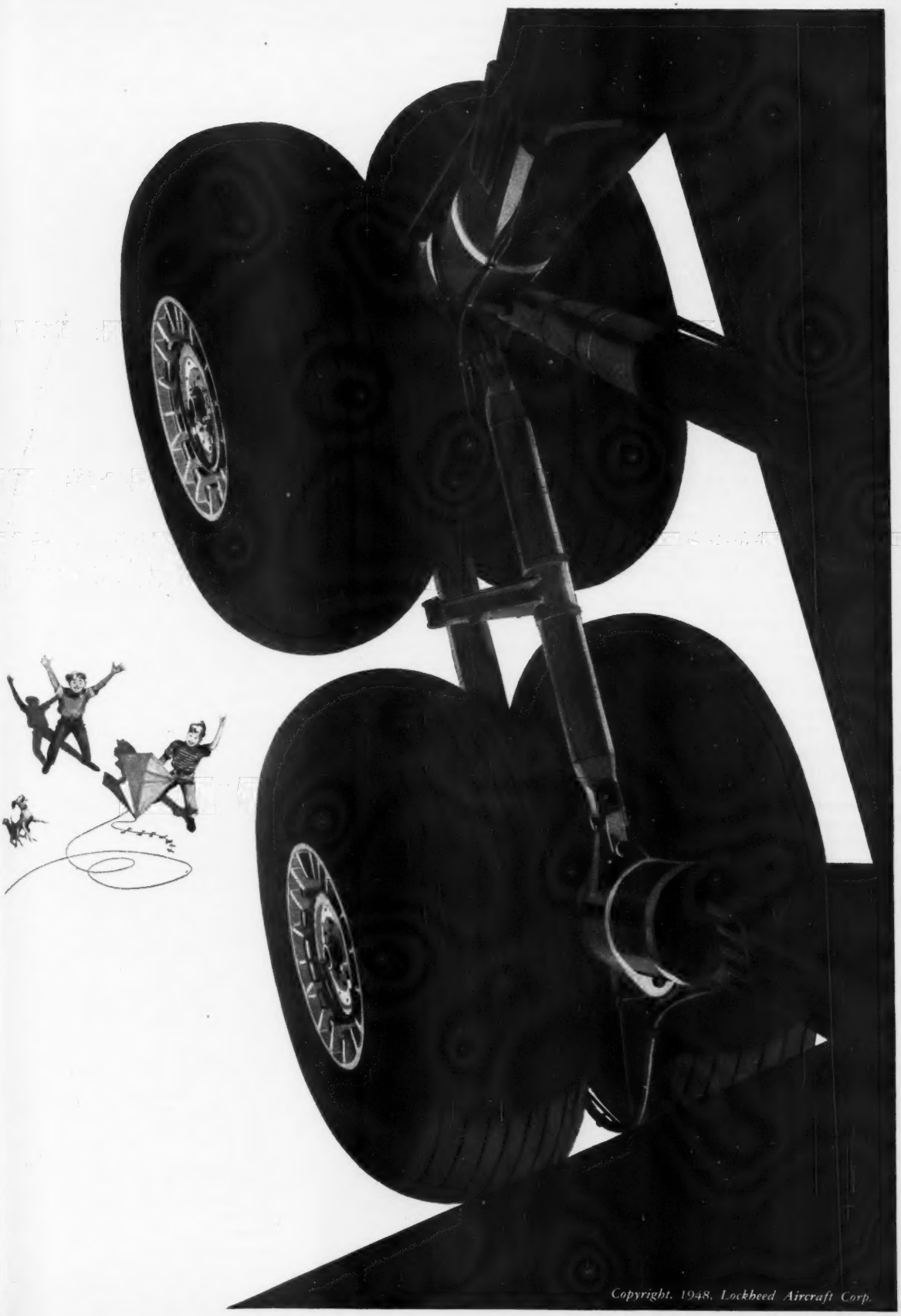

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and reduced take-off thrust at airfields under summer weather conditions.

On February 25 members of the fourth year aeronautical engineering course toured the Etobiocoke plant of the Aluminum Company of Canada.

Tri-State College

Speaker of the evening, George Trich, former Design Engineer at North American Aviation, Inc., gave a general description of his experience of some $10^1/_2$ years with North American at the Student Branch's February 11 meeting, Chairman Dino H. Kintis presiding.

A Tri-State graduate, Mr. Trich had been directly associated with many North American projects, including the AT-6 trainer, the B-25 medium bomber, and the XFJ-1 Navy jet fighter.

Present at the meeting were Profs. S. M. Acton, Honorary Chairman, and Q. J. Hawthorne, Department Head.

A film, *Working on Air*, shown at the February 25 meeting, covered the development of Aeroproducts' constant-speed propeller from the original concept.

On March 11 a banquet-meeting was held, and the results of the election of officers for the Spring term were announced by Secretary Wayne C. Austin. New officers were: Chairman, David J. Russell; Vice-Chairman, Rocco A. Laurito; Secretary-Treasurer, Robert B. Kelley; Student Council Representative (Jr.), Raymond F. Boose; Student Reporter, Dino H. Kintis. Donald J. Eddy was named Senior Student Council Representative.

George Trich, who gave a brief congratulatory address to graduating members of the Student Branch, Honorary Chairman S. M. Acton, and Profs. Q. J. Hawthorne and H. R. Wright were present.

University of Washington

On January 23, members went on a field trip to the local plant of Hoppicopters, Inc. Approximately 40 engineering students and professors attended, hearing present and future plans of the organization discussed by H. Pentecost, inventor of the craft.

At the March 3 meeting, two films were shown, *Boeing Stratocruiser* and *Army GCA*. Howard A. Stine, Chairman, presided.

West Virginia University

Election of officers took place at the Student Branch's February 17 meeting with following results: Honorary Chairman, Henry W. Woolard; Chairman, Ralph C. Cokeley; Vice-Chairman, F. Robert Morrison; Recording Secretary-Treasurer, Carl R. Huss; and Corresponding Secretary, Joann Berry.

Chairman Cokeley appointed a By-Laws Committee composed of E. A. Bryce, Chairman, and D. W. Bennett and James M. Cubbage, Jr.

Harry L. Richardson was appointed chairman of a committee to prepare a display for the Engineering Show. Other members of the committee are: F. R. Morrison, C. R. Huss, W. E. Lawson, A. J. Carman, and C. B. Wagoner.

At the March 4 meeting Chairman Cokeley turned the meeting over to E. A. Bryce, Chairman of the By-Laws Committee for a discussion of proposed by-laws.

A Meetings and Papers Committee was appointed in accordance with the By-Laws with E. A. Bryce as Chairman. Other members included J. M. Cubbage, Jr., and J. M. Pickens.

Harry L. Richardson reported on progress made by the Engineering Show Committee.

News of Members

Stewart P. Adams resigned from The Glenn L. Martin Company to become Design Layout Engineer with Chase Aircraft Company.

Charles R. Beltz, former Field Engineer, Chrysler Corporation, now is owner, Charles R. Beltz & Company.

Carl F. Blakely, who had been with Socony Vacuum Oil Company as Aviation Engineer, has been named Liaison Engineer, Boeing Airplane Company.

A. Stanley Bramow is Patent Examiner, U.S. Patent Office, Washington, D.C.

Given Brewer is in charge of Research & Development, E. Anthony & Sons, Inc.

Roy H. Burita was named Engineering Draftsman, North American Aviation, Inc.

Forrest Campbell, Jr., former Draftsman, Byrnes Associates, resigned to fill same position with Design Service, Inc.

Walter M. Davies, formerly with Allied Aircraft Company, Inc., as Secretary & Treasurer, was named Engineering Designer A, Consolidated Vultee Aircraft Corporation, Fort Worth Division.

Harold W. Davis is with Chase Aircraft Company, Inc., as Designer.

Dr. F. N. Frenkiel resigned from Cornell University staff to become Physicist, Mechanics Division, Naval Ordnance Laboratory, Silver Spring, Md.

Col. Arthur L. McCullough.

James Gaz, Air Force veteran, was named Tool Designer, McDonnell Aircraft Corporation.

William H. Graham, Jr., is Technical Writer, Air Reduction Company.

Chester I. Keasling is Partner-Owner, Vanoni-Keasling Aircraft Company.

Robert L. Lohman is Senior Aerodynamicist, The Glenn L. Martin Company.

Colonel Arthur L. McCullough, veteran P.A.A. Captain and commanding officer of Fourth Bomb Wing, Air Force Reserve unit based at Mitchel Field, received the Legion of Merit at a special meeting attended by 300 members of the Wing. Presentation was made by Major Gen. Robert M. Webster, Commanding General, First Air Force.

John L. Mitchell, who had served as Assistant Air Attaché, British Embassy, Washington, is a Squadron Leader, Royal Air Force.

Sheldon J. Noreen is Design Engineer, Navy Research Project, University of Southern California.

Millard F. Perry has been named to General Electric's Air Conditioning Department, Automatic Heating Equipment Engineering Division as Design and Development Engineer.

William H. Raser, Jr., Air Force veteran, is Aerodynamicist, Piasecki Helicopter Corporation.

Cyril Bruce Rogers resigned from Convair, Fort Worth Division, to become Structures Engineer, North American Aviation, Inc.

Dr. Robert N. Scanlan, former Senior Research Engineer, Republic Aviation Corporation, now is Associate Professor of Aeronautical Engineering, Renssaeler Polytechnic Institute.

Thomas H Townsend, Jr., was named Instructor, Mechanical Engineering Department Mississippi State College.

Meredith C. Wardle is President, Aquaflight, Inc

Victor Warshaw is with Chase Aircraft Corporation as Layout Design Engineer.

Harold P. Westman was promoted to Editor, *Electrical Communication*, International Telephone & Telegraph Corp.

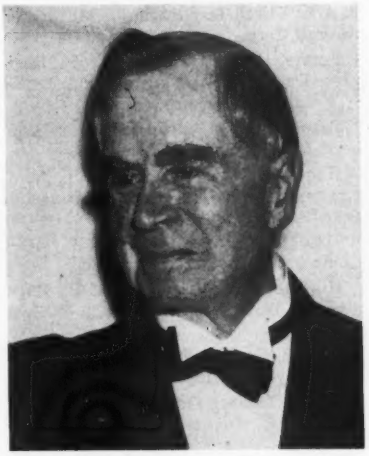
Necrology

Griffith Brewer

Friend and defender of the Wright brothers, Griffith Brewer, British balloonist and pilot, died at the age of 80 on March 1.

An early friend of the Wrights, he had supported the brothers in their claim to having invented the first heavier-than-air flying machine. He made a flight with Wilbur Wright at Le Mans, France, and learned to fly in 1914 at the Wright Brothers School in Dayton. Said to be the first Englishman to fly in the heavier-than-air type of aircraft, Mr. Brewer continued his flying until all private planes were grounded by the British government when World War II started in September, 1939.

A Past-President of the Royal Aeronautical Society of Great Britain, Mr. Brewer came to the United States in January, 1941, in that capacity to appeal for American aid for his country in the war. He was guest of honor at the Honors Night Dinner at the Institute's Ninth Annual Meeting, speaking on "Fifty Years of Aeronautical Experiences."



Griffith Brewer.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to Associate Fellow Grade

Hoekstra, Harold D., B.S. in A.E., Chief Engineer, Aircraft & Components Service, C.A.A.

Lock, Christopher N. H., M.A., Sr. Principal Scientific Officer, Dept. of Scientific & Industrial Research, National Physical Lab. (England).

Transferred to Associate Fellow Grade

Brush, Edward Earl, B.S. in M.E., Head, Dept. of Aero. Engineering, A & M College of Texas.

Carlson, Russell Mansfield, M.S. in A.E., Project Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Connolly, Thomas Francis, M.S. in A.E., Comdr., Executive Officer, USS "Rendova" (Aircraft Carrier), U.S.N.

Fahrney, Delmer Stater, M.S., Capt., Dir. of Pilotless Aircraft Div., Bureau of Aeronautics, U.S.N.

Elected to MEMBER Grade

Brilmyer, Harold George, B.A.E., Sr. Stress Analyst, Structural Research & Development Group, The Glenn L. Martin Co.

Couts, Robert James, B.C.E., Design Engineer, Goodyear Aircraft Corp.

Gerstenberger, Walter, M.S., Chief Vibration Engineer, Sikorsky Aircraft Div., United Aircraft Corp.

Gustafson, Robert Lewis, B.S., Asst. Chief of Aerodynamics, Grumman Aircraft Engineering Corp.

Herr, Donald Lincoln, E.E., Executive Engineer, Controls Systems & Electrical Control Devices, Allen-Bradley Co.

Jevitt, Stanley Joseph, B.S., Project Engineer, Flight Test Div., General Engineering & Consulting Lab., General Electric Co.

Klurfeld, Samuel, B.C.E., Asst. Project Engineer, Edo Corp.

Robertson, Donald Kent, B.S., Vibration Engineer, The Glenn L. Martin Co.

Roop, John Milton, B.S., 1st Lt., Standards Engineer, Asst. to Chief, Specifications Br. A.M.C., U.S.A.F. (Wright Field).

Russell, Cyril Henry, Director, Consul Designs Limited (England).

Schick, Howard Earl, Sr. Aerodynamicist, The Glenn L. Martin Co.

Schmitz, William Arthur, Engineering Test Pilot, North American Aviation, Inc.

Smith, Allen E., M.E., Product Engineer—Marketing Dept., Socony-Vacuum Oil Co., Inc.

Solvey, Joseph, M. of M.E., Aircraft Design Engineer, Council for Scientific & Industrial Research Div. of Aeronautics (Australia).

Transferred to MEMBER Grade

Adams, Alfred Anthony, B.S. in A.E., Sr. Aerodynamicist, Columbus Plant, Curtiss-Wright Corp.

Amico, Gaetano Vincent, B.A.E., Sr. Stress Analyst, Development & Research Group, Republic Aviation Corp.

Angle, Ellwyn Edgar, B.S. in C.E., Aero. Research Engineer P-3, Langley Mem. Aero. Lab., N.A.C.A.

Armbrust, Charles Michael, "A" Layout Draftsman & Checker, The Glenn L. Martin Co.

Bender, Welcome William, Jr., M.S., Technical Director, Pilotless Aircraft Section, The Glenn L. Martin Co.

Bennett, John Thomas, Structures Engineer, Northrop Aircraft, Inc.

Blom, Trygve, B.S. in A.F., Civilian Technical Asst. to Chief of Engineering Div. and Chief of Engineering Operations, A.M.C., U.S.A.F. (Wright Field).

Bernstein, Allen Irwin, M.A.E., Sr. Stress Engineer, Republic Aviation Corp.

Finamore, Odilio Bernard, B.A.E., Aerodynamicist, Cornell Aero. Lab.

Lind, Jack Raymond, M.S. in Eng'g. (Aero), Aerodynamicist, Douglas Aircraft Co., Inc.

Peters, Wesley Hall, Member, Aerophysics Dept. & Sr. Design Engineer, Goodyear Aircraft Corp.

Smith, Norman Yost, B.S. in A.E., Stress Analyst "A," Landing Gear & Controls, Consolidated Vultee Aircraft Corp.

Elected to Associate Member Grade

Carroll, Ursula F., President, Carroll Aeronautical Associates.

Kabalee, Purshottam Meghji Vallabhdass, Technical Advisor, Jupiter Airways Ltd. (India).

Patek, Robert, Ph.D. (Economics), Technical Data Translator, Air Documents Div., A.M.C (Wright Field).

Pine, Cecil C., Flight Test Engineer, Sperry Gyroscope Co.

Zone, Fred, Inspector, Liaison Inspection Quality Control, Republic Aviation Corp.

Elected to Technical Member Grade

Carroll, Don Moffatt, Sr. Draftsman, Power Plant & Control Installations, Piasecki Helicopter Corp.

Fahmy, Amin Abd El Messih, B.Sc., Asst. Foreman 1/C C. of A., British Overseas Airways Corp. (Egypt).

Hall, Fernando Caggiano, Capt.—Pilot, Brazilian Air Force.

Hermanns, Henry Maxwell, Instructor, Rising Sun School of Aeronautics.

Marzella, Joseph Victor, B.S., Test Engineer (Aero.), Flight Test Section, Aero. Structures Lab., Naval Air Experimental Station (Pa.).

McCall, Albert G., Jr., Layout Draftsman "A," Airframes Structures Group, The Glenn L. Martin Co.

Miranda-Corréa, J. C., Capt.—Pilot Brazilian Air Force.

Overbey, James Thomas, B.S. in M.E. (Aero.), Instructor in Aero. Engineering, University of Oklahoma.

Parriott, Wayne Eugene, M.S. in A.E., Aerodynamicist (Government Project), University of Chicago.

Pontious, Rolland Clifford, Research Lab. Analyst "A," Northrop Aircraft, Inc.

Presnal, Allister L., B.Sc., Aero. Engineer, Anderson, Greenwood & Co.

Transferred from Student to Technical Member

Anderson, Howard Walter, B.S. in A.E.

Becerra, Lawrence R.

Boston, Joe Calvin, B. of Aeronautics, Aero. Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Brandt, Frederick Ernest, Ae.E., Draftsman A, Aircraft Turbine Div., De Laval Steam Turbine Co.

Carlstrom, Robert A., B.S. in A.E., Engineer—Design, Grumman Aircraft Engineering Corp.

Clift, Charles D., Jr., A.A., Instructor, Spartan Aircraft Co.

Davis, James Guy, B.A.E., Research Engineer, United Aircraft Corp.

Dibler, Edward Andrew, Jr., Associate in Arts, Flight Test Engineer, McDonnell Aircraft Corp.

Frame, George Leon, B.Sc., Jr. Engineer, Development & Installation, Lester B. Knight & Associates.

Francis, James Edwin, B.S., Jr. Engineer, Boeing Airplane Co.

Haneman, Vincent S., Jr., B.S., Aero. Engineer, Supersonic Lab., Massachusetts Institute of Technology.

Heit, John G., B.S., Service Engineer, Consolidated Vultee Aircraft Corp.

Hinders, Urban A., B.Sc. in A.E., Engineer in Training P-1, A.M.C. (Wright Field).

Hooton, Samuel Bagol, B.A.E., Salesman, Hart-Greer Inc.

Horeff, Thomas Gregory, B.S. in A.E., Flight Test Engineer, McDonnell Aircraft Corp.

Kaplan, David H., B.A.E., Aeronautical Engineer, Piasecki Helicopter Corp.

Klose, Walter G., B.S.A., Apprentice Engineer, Grumman Aircraft Engineering Corp.

Kneuer, Arthur Thomas, Quality Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Low, George M., B.A.E., Mathematician A (Aerodynamicist), Consolidated Vultee Aircraft Corp.

Marsh, Billy Wayne, B.S. in A.E., Aerodynamics Group, Consolidated Vultee Aircraft Corp.

Mohrman, Robert Floyd, B.A.E., Engineer, Grumman Aircraft Engineering Corp.

Nauert, Henry E., B.S. in A.E., Sr. Detailer, McDonnell Aircraft Corp.

Neff, James Ray, Associate in Art in A.E.

Pratt, John Warren, Jr., B.S. in A.E., Refinery Equipment Engineer, Butane Equipment Co. Inc.

Schweiger, Marvin I., B.A.E., Engineer—Research Dept., United Aircraft Corp.

Sherling, William George, Jr., B.S., Instructor, Alabama Polytechnic Institute.

Slavin, Morton Arthur, B.A.E., Aero. Engineer, General Electric Co.

Spencer, Ronald D., Engineer, Grumman Aircraft Engineering Corp.

Stitt, Leonard Eugene, B.Sc. in A.E.

Vinicky, Benedict M., B.S.A.

Unified Design for Performance and Safety Characteristics

(*Continued from page 29*)

has not been made soon enough. (3) If a severe gust should cause a complete stall, the lateral stability and control characteristics are such that the pilot can fly into it and back out again without great skill.

Spin Characteristics.—With partially restricted controls the airplane is nonspin. It will enter a spiral with radius about three spans and with a comparatively low rate of descent.

With unrestricted controls the spiral is much tighter and very steep like a spin. The recovery is made merely by releasing the lateral control without use of the pitch control.

The entry is slow and preceded by such excellent stall warning and stall characteristics that a higher safety rating is obtained with the unrestricted controls.

This same philosophy is further reflected in the evaluation of Table 1 for the safety rating factor for three full controls as compared to that for two restricted controls.

The safety rating factor of Model 52 as given by Table 2 is 2,895.

(IV) Conclusion

The methods presented, using the chart and factors, have led to an airfoil-flap-aileron design with improved stall characteristics and high-performance rating. The quantitative relations defining the factors provide a means for determining the effect of all pertinent parameters on the resultant design as a unit.

The safety-rating factor is most difficult to define. The pilot element and the closer relation to the actual design require the use of statistical data for each design type or component. Complete data are not available. However, using existing data, a weighted listing of items for a personal-type airplane was set up which proved to be adequate for the purpose intended. With the development of new designs and the availability of better data, the relations used in the listings can be modified accordingly.

Application of the chart to the development of a two-place tractor airplane is cited as further indication of the results that can be obtained by the systematic unified approach to the flight and ground handling problem presented.

References

[1] Durand, W. F., *Aerodynamic Theory*, Vol. II, p. 68; Julius Springer, Berlin, 1934.

[2] Weick, Fred E., and Jones, Robert T., *Résumé and Analysis of N.A.C.A. Lateral Control Research*, N.A.C.A. T.R. No. 605, 1937.

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Electrical and Electronic Engineers—Graduate electrical engineers, 3 to 5 years' experience in design and development work. Must be qualified to do original circuit design work. Experience in electronic computer design desirable. Write Personnel Manager, Link Aviation, Binghamton, N.Y. Interviews will be arranged.

Instructor—Engineer—The Test Pilot Training Division of the Naval Air Test Center, Patuxent River, Md., requires two aeronautical engineers to instruct student test pilots in aeronautical engineering fundamentals and test procedures and to act as a test-methods development group. Ratings offered Aero-Engineer (Aerodynamics) P-5 or P-6 at $5,905.20 to $7,102.20 per annum and Aero-Engineer (Power Plants) P-4 or P-5 at $4,902.00 to $5,905.20 per annum. Experience in testing, teaching, or experimental work required. Address replies to Director, Test Pilot Training Division, Naval Air Test Center, Patuxent River, Md. Civil Service Application Form 57 may be included.

Aeronautical Engineer (General)—The U. S. Naval Air Station, Quonset Point, R. I., has vacancies for Aeronautical Engineer (General) P-5, $5,905.20 a year. Qualifications—In addition to a degree in engineering or 4 years of successful progressive technical engineering experience, applicants must have had at least 4 years of progressive professional engineering experience. Duties—Directs and supervises an Aeronautical Engineering Section in the overhaul and repair of all types of aircraft components. Responsible for the design of aircraft parts and assemblies and for the correct and accurate preparation of sketches and drawings. Applicants should file Standard Form 57 (obtainable at any First or Second Class Post Office) with the Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I.

Aeronautical Engineer (Power Plants)—The U. S. Naval Air Station, Quonset Point, R. I., has vacancies for Aeronautical Engineer (Power Plants) P-3, $4,149.60 a year. Qualifications—In addition to a degree in engineering or 4 years' successful and progressive technical engineering experience, applicants must have had at least 2 years of professional engineering experience. Duties—Responsible to investigate and make recommendations for action on engineering requests from the Engine Overhaul Division of the Assembly and Repair Department. Prepares smooth drafts of local engineering specifications, engineering instructions, drawings, sketches, and other technical data and reports. Applicants should file Standard Form 57 (obtainable at any First or Second Class Post Office) with the Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I.

Engineering Draftsman (Aeronautical)—The U. S. Naval Air Station, Quonset Point, R. I., has vacancies for Engineering Draftsman (Aeronautical) SP-5, $2,394.00 a year. Qualifications—Three years' total drafting experience, which must have included 9 months of specialized experience in the aeronautical field of drafting; or 3 years or more of college or university study in architecture or aeronautical engineering may be substituted for the experience required above. Duties—Prepares sketches, designs, and drawings for the repair, installation, or modification of aeronautical fixed equipment, allied components, and air-frame assemblies and structures in connection with the modification, overhaul, and repair of aircraft. Applicants should file Standard Form 57 (obtainable at any First or Second Class Post Office) with the Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I.

Flight Test Engineer—Flight-test program for the development of automatic flight controls requires engineer to assist on project work. Work includes planning of installations of test equipment and electrical recording gear and its operation in flight. Applicant should be familiar with aircraft operations and possess a background in aeronautical or mechanical engineering plus some knowledge of electrical equipment and dynamics. Address replies to Mr. A. F. Coleman, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

Professor or Instructors—Salaries comparable to industrial salaries. Opportunities for research and writing. Excellent facilities. Fields: engineering, transportation, and operations. Address: Director, University of Southern California, College of Aeronautics, Santa Maria, Calif.

Helicopter Aerodynamicist—Experienced, required for long-term development program for U. S. Air Force. Apply in writing to Manager, Helicopter Division, Kellett Aircraft Corporation, North Wales, Pa.

Aerodynamicists, Thermodynamicists, Stress Analysts, Aircraft Designers—North American's engineering program offers a number of excellent openings in the classifications above for qualified engineers. Salaries commensurate with training and experience. Please include complete details in reply. Engineering Personnel Office, North American Aviation, Inc., Municipal Airport, Los Angeles 45, Calif.

Research Engineers—Openings for experienced aerodynamicists, thermodynamicists, and electronic engineers with opportunity for research in supersonics. Openings also for engineers with jet engine test experience. Please include complete résumé of experience and education in reply. Write to: Consolidated Vultee Aircraft Corporation, Lone Star Laboratory, Daingerfield, Tex.

Aeronautical Engineers—Aircraft research engineers and scientists needed for work on task research programs. Projects under way require men with the ability to apply the theories of dynamics, structures, aerodynamics, thermodynamics, and aircraft design to the solution of varied applied research problems on airplanes, helicopters, and guided missiles. Educational background and knowledge should approximate that required for a Masters Degree in Engineering or Physics. Experience desirable but not so essential as a good basic training and a well-developed scientific curiosity. Cornell Aeronautical Laboratory, Employment Office, 4455 Genesee St. Buffalo 21, N.Y.

856. Engineer—Graduate in Aeronautical or Civil Engineering to assist in structural analysis of aircraft and similar components. Two or 3 years of practical stress experience or equivalent in specialized training desirable. Must have ability to write technical reports.

849. Mechanical Designer—Small organization requires engineer to take charge of mechanical design activities. Familiarity with aircraft requisites highly desirable. This is an excellent opportunity for the properly qualified man who is able to accept responsibility. Give full details of education, experience, and salary expected.

848. Analytic and Design Engineer—Small New England organization building complete aircraft requires a versatile graduate engineer. Must be capable of accepting responsibility in design and in the preparation of analytic and stress analysis reports. Knowledge of aerodynamics, vibration, and testing procedure highly desirable, particularly rotary wing. This position offers a unique opportunity for the properly qualified engineer. Give full details of education, experience, and salary expected.

834. Helicopter Pilot—Experienced helicopter pilot with over 150 hours' helicopter time. Commercial operator desires chief pilot to take charge of operations.

832. Mechanical Designer—Instrument field; Long Island area. Must be capable of handling complete design of small precision mechanical computers involving numerous automatic inputs.

830. Engineer—High-caliber; flight-test operations experience necessary; pilot experience desirable. Must be graduate engineer. East Coast.

823. Pilots—Experienced helicopter test pilots wanted. Must have a minimum of 100 hours of helicopter flying time. Engineering background desirable. Preferably service trained. East Coast concern.

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871. Sales-Survey-Management Engineer—B.S. in Business and Engineering Administration, M.I.T.; 3 years' aeronautical engineering; 1½ years' engineering administration. Recent experience in aircraft export sales management including foreign contacts. Also some business survey and analysis background. Commercial pilot with civilian instructor rating; military multiengined experience. Married, age 26. Any location (including foreign) considered seriously.

870. Director of Research—Rocket motors. Experienced.

869. Engineer—B.S. in E.E., M.S. in Ae.E. Four and one-half years' experience in development, test, and manufacturing of automatic flight control systems for conventional aircraft and guided missiles. Desires position in New York City area.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

868. Management or Administration—A.B. degree, University of Pennsylvania; 28 years old; single. Major in political administration, courses applicable to business administration. Courses in industrial engineering including industrial relations, business and Government, organization and organizational structure. Aeronautical engineering courses in elementary aerodynamics, performance calculation, aircraft drafting, and engineering. Over 4 years in aircraft testing in present position. Desires permanent position on junior level in management or administration with opportunity for advancement. Philadelphia, Pa.

867. Washington Representative—B.S. in Aero. Engr., married, firmly established in Washington, available for full or part-time work as technical representative. Experience with U.S. Air Forces, Bureau of Aeronautics and N.A.C.A. in structures, materials, helicopters, and personal equipment. Familiar with the present research and development programs of the services on materials.

866. Layout Draftsman—Six years' experience in aircraft industry. Four years' experience on fuselage and electrical installation. Desires responsible layout position. Will locate in New Jersey or New York.

865. Structural Engineer—B.S. in M.E. Age 29; single. Eight years' experience in aircraft design with large concern. Five years in stress analysis, 2 years in static test, and 1 year in drafting. Mechanically inclined. Familiar with military and C.A.A. requirements. Will locate anywhere in U.S. Desires position utilizing experience and offering advancement.

864. Management Executive—B.S. in M.E. Over 20 years' experience in aviation, including engineering, production, quality control, contracts, contract termination, labor problems, materials, costs, and sales. Five years' research, N.A.C.A. hydrodynamics and aerodynamics. One year flight performance data analysis. A & E mechanic, private pilot. During war represented the Bureau of Aeronautics in plants of major aircraft manufacturers, heading staffs up to 160 engineering, clerical, and shop personnel. Present position: directing rocket and air engine test and development at Navy test center. Long experience in dealing with Government agencies. Desires responsible position with an organization needing a versatile, well-informed executive.

863. Research Administrator—Six years' industrial design, 8 years' chief research engineer large corporation, 3 years' professor and consultant for large engine builder, 8 years' director of university aeronautical research laboratory, 14 years' part-time teaching. One hundred and fifty patents. Specialized in power-plant, Government, and industrial contracts. Age 53. Broad experience. A-1 references.

862. Engineer—Graduate (majors in Physics and Mathematics) of University of California. One year's graduate work in Physics. Five years' experience as a stress analyst and dynamicist in aeronautical engineering. Position preferred in Los Angeles area.

861. Physicist-Aerodynamicist—Age 42. B.S. degree in Physics and Mathematics and 1 year graduate study in physics. Professor of Aeronautical Engineering with administrative experience and 12 years of nationally recognized work as research physicist with the N.A.C.A. Desires responsible position teaching aerodynamics, theoretical and applied mechanics, and related subjects (including related research).

860. Aeronautical Engineer and Thermodynamicist—B.Ae.E., Rensselaer Polytechnic Institute, 1940. One year's experience as junior engineer at N.A.C.A. Six and one-half years' experience with aircraft manufacturer and present employer. Four years' in aerodynamics department doing general performance work and specializing in engine cooling, cowling, ducting, heat exchange and all internal flow on aircraft for reciprocating and turbojet engines. The past 2½ years spent as head of engine research group conducting compressible flow analyses in connection with current active missile designs. Specialized in supersonic diffusers and in ram-jet engine performance. Familiar with turbojets, pulse-jets, and present-day rockets. Desires position dealing with research on ram-jets, diffusers, supersonic wind tunnels, general flow problems, or any active engine program for use on missiles. Organization or university should have a sound and stable outlook for future work in the research field. Desirable to have facilities available for continuance of education.

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858. Service Engineer—Engineering training and background; A & E license. Considerable experience as company representative on Navy experimental airplanes. Experienced in investigating service troubles and writing service bulletins to cover same; compiling technical manuals.

857. Aeronautical Engineer—Teacher, with 7 years of experience in the aircraft industry and the aeronautical teaching field, is looking for a new connection either in teaching or in industry. Aircraft industrial experience includes administration of engineering programs resulting in C.A.A. type approval along with the necessary personal contact work. Complete knowledge of the civil air regulations gained through several years with the C.A.A. Experience in design and stress analysis includes considerable work in rotating wing aircraft, as well as general aircraft design. Nonaircraft experience includes work in optics and refrigerating unit design. Teaching experience includes presentation and development of courses in wind-tunnel operation, aerodynamics, high-speed aerodynamics, design, stress analysis, propeller design, and rotary wing aerodynamics. Author of several published papers in the fields of

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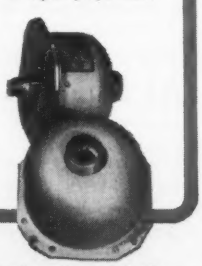

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850. Aeronautical Engineer—Age 26; B.S. in M.E. Will receive M.S. in A.E. (Jet Prop. Option) from California Institute of Technology in June, 1948. Experience includes one semester as instructor in mechanics, 2 years in aircraft research laboratory, and 2½ years as stress analyst on large military aircraft. Currently employed in GALCIT wind tunnel. Desires either academic or industrial position with good future.

847. Administrative Engineer—Age 26; S.B. aeronautical engineer, S.B. business and engineering administration, M.I.T. Five years' experience in operational and maintenance engistress analysis and design. Education consists of Bachelor's and Master's degrees in Aeronautical Engineering from large Eastern university. Full details and a list of references will be supplied on request. Location open.

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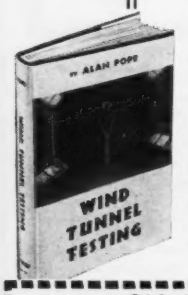

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842. Associate Professor—Associate Professor of Aeronautical Engineering, Doctor of Aeronautical Engineering, seeks change of position. Possesses engineering, as well as mathematics, advanced degrees. Major field: theoretical aerodynamics and gas dynamics.

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840. Aeronautical Engineer—M. Aero. Eng.; age 33. Ten years' experience in flight test and operational engineering, air-line operations, sales and market research, and technical writing. Wide contacts in air transport and manufacturing fields. Desires position as assistant to executive, or sales engineer, in New York or New England area.

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824. Associate Professor—B.S., M.S., receives Dr. Eng. (Aero.) in June, 1948. Broad experience includes: 5 years' graduate work and structural research; 4½ years in industry as stress analyst and structural test engineer; 4 years as Assistant Professor of aeronautical engineering teaching most of the undergraduate work in established department. Desires academic position handling senior and graduate courses (and related research) in aeronautical engineering or applied mechanics. Available in June.

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Annual Summer Meeting—Hotel Ambassador, Los Angeles—July 14–16

Members or organizations wishing to submit papers for presentation at National Meetings should send outlines or summaries to the Committee at least 3 months prior to the meeting.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to The Meetings Committee, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

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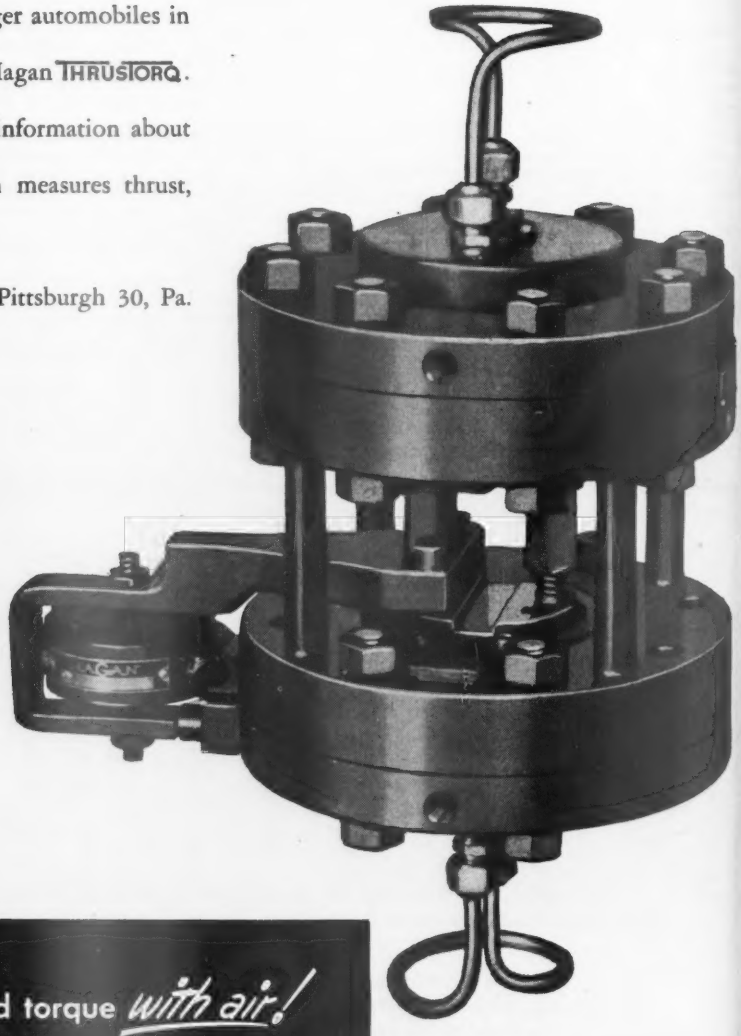

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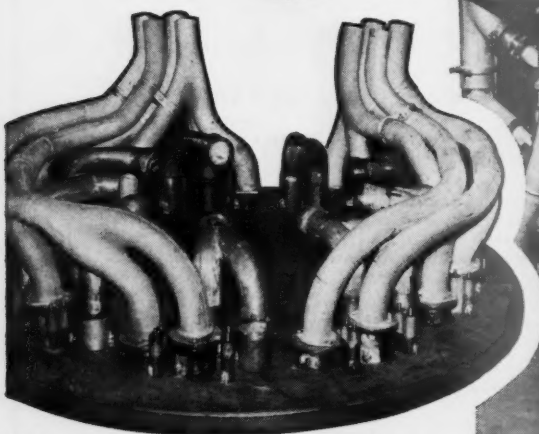

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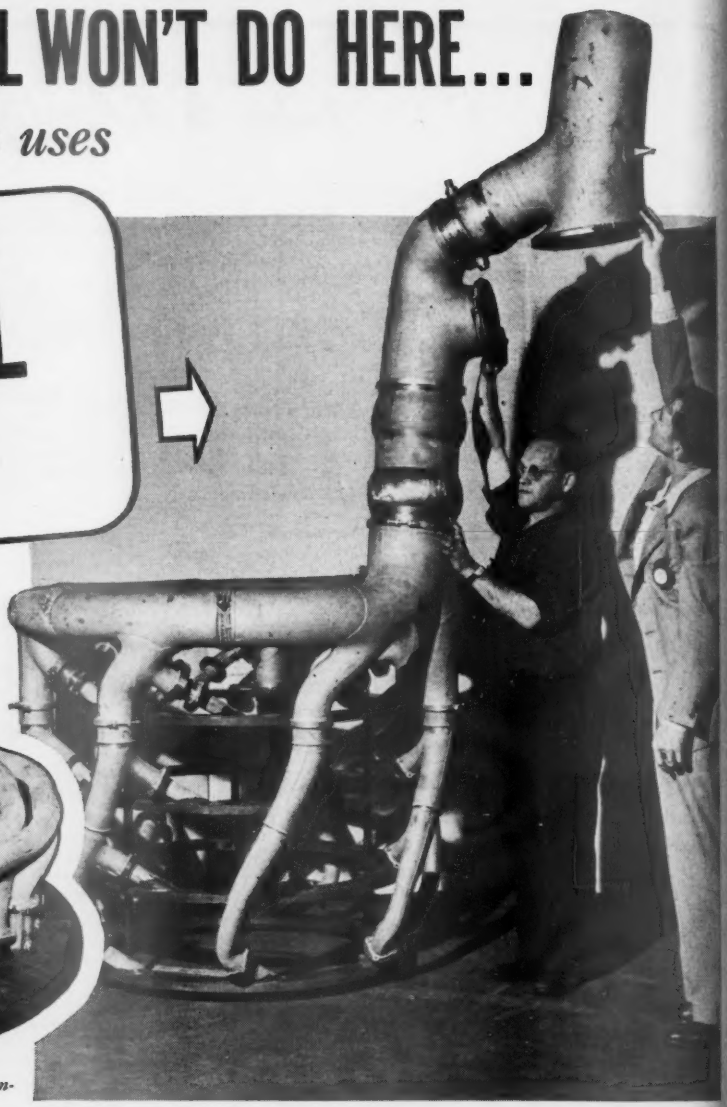

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